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REGULAR FEATURES

The Course of Oil 12
Scanning Washington's Oil Horizon 14
National Petroleum Situation ..... 16 and 17
Highlights in Oildom 18
Major Oil Field Activities 20
Major Pipe Line Activities 22
Major Refining Activities 24
Machinery and Equipment ..... 251-266, inclusive
Trade Literature 264
The Petroleum Engineer's Continuous Tables (Installment No. 93) 267
Running Tour With Men in the Industry ..... 283, 284, and 286
Laugh With Barney 288
Book Reviews 302

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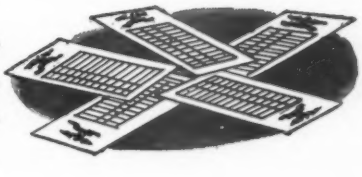

Passing this particular ammunition requires that you reappraise your own company's Payroll Savings Plan. Have your own War Bond Chairman contact the local War Finance Committee—today! They will welcome the chance to discuss this new program with you.

The Treasury Department acknowledges with appreciation the publication of this message by

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The Course of Oil

by K. C. SCLATER

OIL FIELDS' RECAPTURE NEAR

Among the early prizes captured by the Japanese were the oil fields and refineries of Burma. After three years, the recapture and subsequent rehabilitation of these fields and refineries is at last in sight.

According to latest reports, allied forces have made a crossing of the Irrawaddy River and penetrated some eighty miles from the east bank of the river to a point within a few miles from the eastern boundary of Burma. This places allied forces some twenty to thirty miles north of the oil fields of Burma. A drive to recapture the oil fields may be in the offing, and if so, immediate steps will probably be taken to rehabilitate them. An effort to recapture at an early date the oil refineries, most of which are in the vicinity of Rangoon, is no doubt on the program of the allied military commanders.

Although no official inkling of what arrangements have been or are being made for putting these fields and refineries back into condition for production, large quantities of oil field and refinery supplies and equipment are likely to be needed. Recapture of the oil fields and refining facilities of Indonesia is likely to follow within a few months. When this happens, the demand for technical personnel, equipment, and supplies may be—at least for a time—beyond the industry's capacity to meet.

UNDERGROUND HELIUM STORAGE

The greatest known source of helium is natural gas. Helium is a highly inert gas only slightly heavier than hydrogen gas and because of its chemical inertness, will not burn. Besides a variety of military uses, helium has a large potential market in scientific and industrial operations—a market that is expected to expand greatly after the war. So great have been the strides made in the efficient and economical extraction of helium from natural gas in the United States that the rate of production is today twenty-five times greater and the cost of production lower than in the prewar period. Extraction of helium from natural gas, which takes place at five different plants operated by the U. S. Bureau of Mines, is under strict government control.

Because of limited storage facilities, large quantities of natural gas have had to be marketed before the helium was extracted and the helium in the gas lost forever. As a means of conserving this valuable product—valuable mainly because of its chemical inertness—the helium will be stored underground.

This is a far-sighted move on the part of the government, the benefits of which will be more apparent in the years to come. It suggests a more extended use of underground storage for surplus natural gas.

GAS PRODUCTION PRORATION

Large as the potential natural gas resources of Texas are, stricter conservation of gas by state regulation is under consideration. Bills toward this end have been or are soon to be introduced in the state legislature. One such bill would specifically authorize the Railroad Commission of Texas to order maintenance of reservoir pressure in natural gas fields. Another bill would prorate the production of sweet and sour natural gas. Both bills are designed to strengthen the conservation laws of the state.

The bill for maintenance of reservoir pressure in natural gas fields would provide "that after notice and hearing by the commission on any particular field or fields the commission is hereby directed to issue an order, where found to be reasonable and feasible, directing the introduction of such gas into such oil, distillate or gas-bearing horizon in order to maintain the pressure to prevent the dropping out of solution of the liquid hydrocarbons, which otherwise would be lost. The Legislature hereby finds that in such fields as referred to above that physical waste will take place unless such pressure maintenance is required by the commission."

This interest in conservation of natural gas stems from the hue and cry raised because of shipment of natural gas from the state by gas pipe line to industrial areas in the East. Those opposed to shipments of large quantities of gas from the state are afraid that the state's natural resources will be so seriously depleted that within twenty to forty years the natural gas supply will be insufficient for domestic and industrial needs within the state.

Gas is an exhaustible resource and regardless of the potential reserves, the fact that the state is becoming so conservation minded in regard to natural gas, as well as oil, is not discouraging. It augurs well for the further wise regulation of oil and natural gas in Texas.

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Strength, endurance and ability to resist wear, tear and bending stresses are the fundamental qualities of every "HERCULES" **(Red-Strand)** Wire Rope. It has been serving the various industries for more than half a century.

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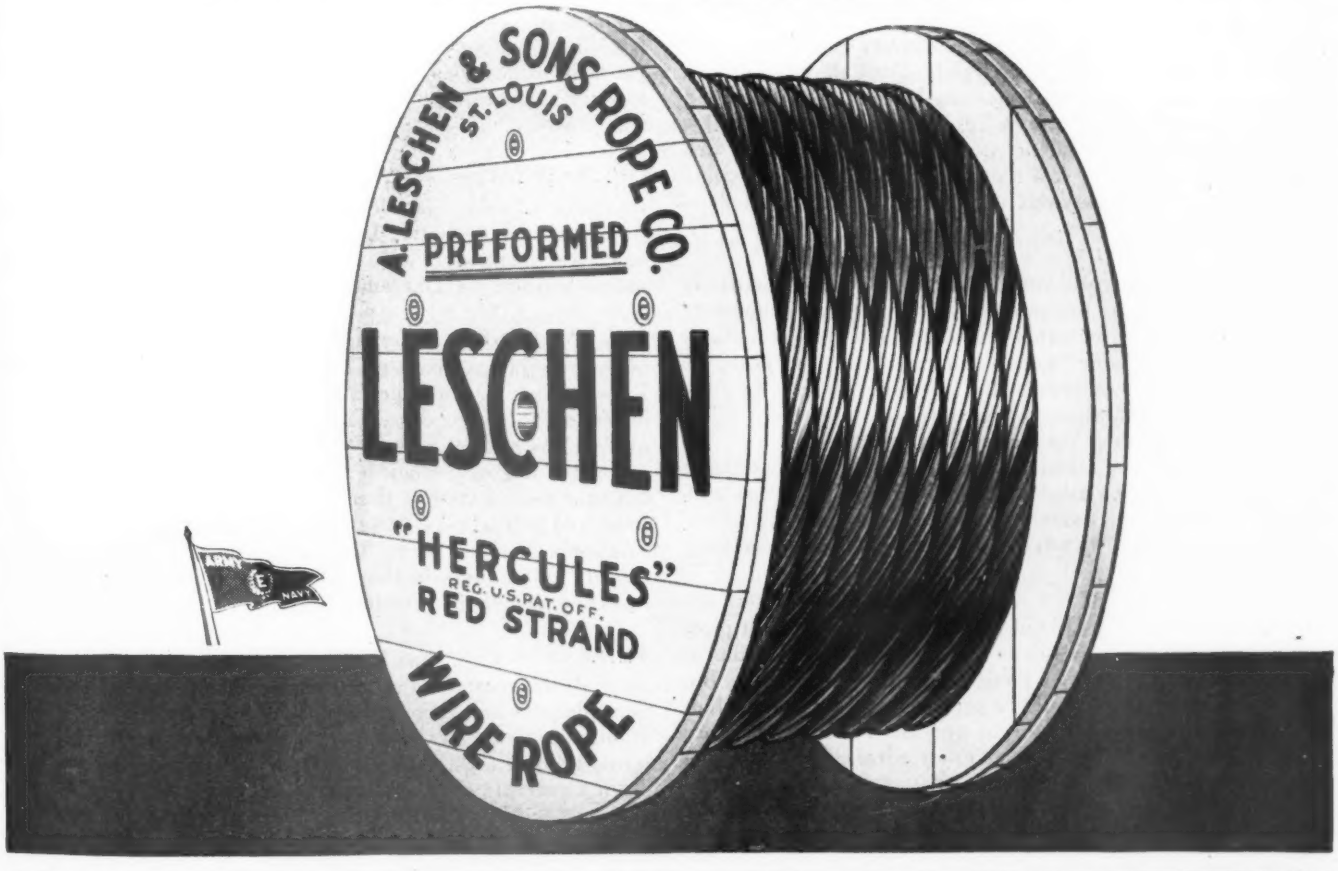

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Scanning WASHINGTON'S OIL HORIZON

MILBURN PETTY

WASHINGTON.—The American oil producer's postwar program shapes up like this: Fight for a crude price increase now that will cover replacement costs, protect that price level after the war with a higher tariff and limitation on imports.

As a first step, Russell B. Brown, Independent Petroleum Association of America's general counsel, is seeking an amendment to the OPA law requiring the price control agency to recognize replacement costs in fixing crude price ceilings.

Tariff and import control will be sought later. Time has come, he feels, for the government actively to encourage the domestic oil industry to find new oil, to preserve a supply within this country for the next war.

Tying in with this, the stripper well operators are assembling data to convince Congress that the present subsidy should be part of our permanent oil conservation program.

Oil treaty fits in. The revised Anglo-American oil agreement fits into this program, producers believe, now that it specifically reserves the right to limit imports into this country and disclaims any intent of federal production control here. In addition, some producers feel the oil treaty will serve as a world-wide proration measure to prevent a surplus.

A majority of the Senate Foreign Relations Committee favors the Anglo-American agreement, as revised to meet the industry's objections. But the anti-trust immunity provision is still unsettled. It may be handled separately. Since the agreement is not self-executory, some implementing legislation will be needed. Some agency will have to be designated to pass on whether anti-trust immunity should be given as each program is proposed. (Some observers feel the industry should be on guard lest this bill carry some extra trimmings, smacking of federal control.)

O'Mahoney quizzes oil execs. Reluctance of the oil companies to act under the treaty unless there is some anti-trust immunity provided was clearly indicated during the government-industry conference with Senator Connally's foreign relations group on February 22. It was evident in the oil men's answers to questions by Senator O'Mahoney, Wyoming, who was there in his capacity as chairman of the Senate Oil Committee.

Senator O'Mahoney asked each oil executive what he thought his company would be asked to do that might violate the anti-trust laws without the immunity clause. Almost without exception, they answered: "We might be asked to increase or cut back production."

OPA AND REFINERS. OPA doesn't expect the crude oil price survey to result in higher prices unless there is an amendment to the law forcing OPA to recognize replacement costs. But OPA feels that refiners should be prepared, should get together their cost figures, because OPA is opposed to a compensatory product price increase if and when crude advances. The alternative, recommended by Congressman Patman's Small Business Committee, is a subsidy for "marginal" refiners who could not afford a crude advance.

ASPHALT TANK CARS. Some limitation on the use of asphalt tank cars is expected; probably a 500-mile limit. But liberal exceptions will be granted to refineries making war products so that there will be no back-up.

100-OCTANE. PAW has approved all the 100-octane projects it thinks necessary to meet the war's requirements. Last five to get under the wire were for Indiana Standard (two) at Whiting, Indiana, and Sugar Creek, Missouri; Leonard Refineries, Inc., at Alma, Michigan; The Texas Company at Lockport, Illinois, and Shell Oil Company at Houston. Other projects being developed have been shelved. PAW decided the materials were more urgently needed for other programs, such as drilling. More than 60 plants are now making 100-octane; another 150 are supplying blending agents.

Consumption of 100-octane will slacken with V-E Day, but only temporarily. As soon as the planes are transferred from Europe to the Japanese fronts, demand will bounce right back again. During the interim, there will be no let-up in 100-octane production. The excess will go into storage.

RIVAL OIL COMMITTEES. California's Congressman Lea won't get to first base with his resolution to continue the House Oil Investigating Committee unless he agrees to step aside as chairman. Prestige of this committee has ebbed since Congressman Cole, Maryland, retired as chairman to accept a judgeship several years ago. Lea took over but continued as chairman of the busy House Interstate Commerce Committee. Many congressmen feel the oil committee, which won the industry's respect from its start in 1934, deserves a full-time chairman.

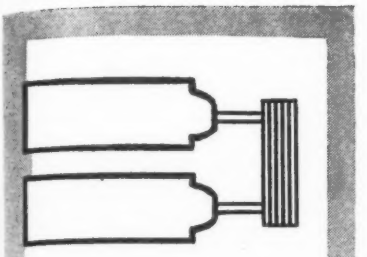
Meanwhile, Senator O'Mahoney is coming up fast as Capitol Hill's oil expert. As new chairman of the Senate Oil Committee, the Wyoming senator is ambitious to investigate thoroughly all branches of the industry, including foreign. In addition, he is polling oil company executives for their views on cartels preparatory to hearings on his cartel registration bill. And he is sponsoring a bill to give small refiners the first call on government royalty oil.

LPG RATIONING. PAW and OPA are discussing plans for rationing liquefied petroleum gases next year (they are not formally rationed now). Due to the 100-octane program and other war demands, PAW expects a tight supply next season unless both the German and Jap wars should be over.

FPC GAS PROBE. Federal Power Commission's investigation of the natural gas industry, opening with hearings May 1 at Kansas City, Mo., will go into "waste" in production and the effectiveness of state conservation laws as well as reserves, "end use" of gas and other angles. Purpose is to gather data for a report to Congress on new legislation found to be needed. Some industry representatives here fear this may be a backdoor approach to federal oil control since oil and gas production tie in so closely in many fields. They point out that the stairway is already half built with the Natural Gas Act and a permanent federal agency administering it.

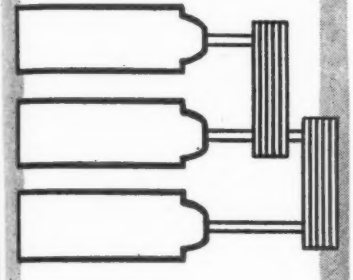
TIDELANDS. California is rallying Senators and Congressmen from all the coastal states to back a bill in Congress declaring that tidelands and submerged offshore lands belong to the state adjoining. Secretary Ickes says a court decision in the California tidelands test case, which he seeks to precipitate, will lay down a general policy applicable to all coastal states. However, some states (Texas, for one) may have to be handled differently, he admits.

PAW PRODUCTION CONTROL. A showdown on PAW'S production control program in California (and other states without proration laws) has apparently been avoided. The producer first accused of overproducing his quota has agreed to cut back to his quota in Coalinga Nose field; in Raisin City, the other field where he was allegedly overproducing, a new formula has been adopted, resulting in higher quotas and he has agreed to abide by his new quota. When PAW dug into the situation, it was found that some other producers were over quota. All have been warned now.



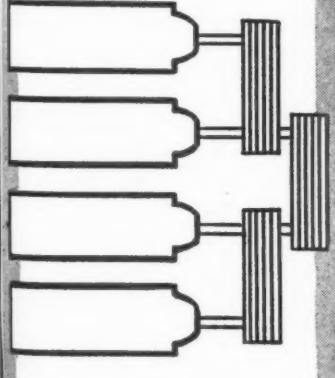
450 hp

The first rigs powered with compounded Cummins Diesels used *two* Model LP-600's, each rated at 225 hp. at 800 rpm., producing a total of 450 hp.



675 hp

Prompted by the success of the two-engine hook-up and also by the trend toward deeper drilling, rig builders fashioned their designs around *three* compounded Model L's which provide a total horsepower output of 675 hp.



900 hp

Visualizing "deep hole" drilling on an increased scale, manufacturers now have in production rigs which call for *four* compounded L's on the drawworks and two L's compounded on the mud pump.

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CUMMINS DIESELS

SINCE 1919...PIONEER OF PROFITABLE POWER THROUGH HIGH SPEED DIESELS

National Petroleum Situation

PRICE VS. EARNINGS. Recent statement of OPA executive that replacement costs are not being considered in crude oil price studies, since earnings of industry constitute primary evidence of adequacy or inadequacy of prices, reveals misconception of economics of oil industry. Studies presented in February issue of The Petroleum Engineer, by H. J. Struth, make clear the fact that replacement costs have quadrupled since 1940. Profits from oil found 10 years ago do not reflect the fact that tomorrow's oil supply will include greatly increased replacement costs.

75-CENT INCREASE NECESSARY. All commodities, according to the U. S. Bureau of Labor are now at a level of 104.9, based upon 1926 levels. Price of crude oil stands at 62 on same basis. If crude price were on parity with all commodities the average price should be $1.97 instead of $1.22—75 cents per barrel under the general price level of all commodities.

DRILLING BELOW QUOTA. Drilling operations in first two months of year were considerably below rate recorded in final months of last year. While February was a short month, with 1,829 completions against 2,081 in January, the quota for the first two months of this year was not met by about 9 per cent. The wildcat drilling quota for the two months is 800, whereas actual results were 660, which is only 82 per cent of the 1945 program to date.

MORE DRY HOLES. Dry hole ratio for the first two months of this year was 27.7 per cent, against 18 per cent in 1944 for development drilling. Wildcat operations are showing about the same dry hole ratio as a year ago.

NEW DEMAND PEAK. February crude oil demand reached a new all-time peak of over 5,000,000 barrels daily. The heavy demand made it necessary for the industry to withdraw from storage over 5,000,000 barrels of crude. Refinery operations in February were at a daily average of 4,823,000 barrels; daily crude output was 4,780,000 barrels.

IMPROVED GASOLINE SUPPLY. Stocks of motor fuel on March 1 aggregated 86,010,000 barrels, against 78,254,000 barrels a year ago. Despite the increase, however, the supply is at the same level as a year ago—43 days. Greater recovery of gasoline from crude processed by refineries has materially aided the gasoline supply picture. Current yield averages 41.1 per cent, against 38.9 a year ago.

SMALLER PRODUCTS SUPPLY. Stocks of all refined oils at the close of February were at about the same level as a year ago, but measured in days of supply only represented 42 days, against 47 days supply a year ago. The particularly heavy demand for fuel oils and sharp withdrawals from inventories have offset the otherwise improved stock position of motor fuel.

Comparative Statistics, February, 1945

*All figures are computed on a Bureau of Mines basis.**

	Feb. 1945(p)	Jan. 1945(p)	Feb. 1944	This year to date	Last year to date	Per cent change
Wells drilling	4,055	(r)4,150	3,232	4,055	3,232	+ 25
Total wells drilled	1,820	2,081	1,520	3,910	2,940	+ 33
Development wells	1,515	1,735	1,242	3,250	2,386	+ 36
Oil	931	1,068	869	1,999	1,724	+ 16
Gas	165	193	149	358	237	+ 51
Dry	419	474	224	893	425	+110
Per cent dry	27.7	27.3	18.0	27.5	17.8	+ 9.7
Wildcat wells	314	346	278	660	554	+ 19
Oil	42	46	43	88	72	+ 22
Gas	13	10	12	23	21	+ 10
Dry	259	290	223	549	461	+ 19
Per cent dry	82.5	83.8	80.2	83.2	83.2	....
Crude production	133,830	146,710	128,901	280,540	264,668	+ 6
Daily average	4,780	4,733	4,445	4,755	4,411	
Crude stocks	224,784	229,925	248,271	224,784	248,271	— 9
Days supply	45	47	55	45	55	
Crude demand†	142,584	151,300	130,476	293,884	268,779	+ 9
Daily average	5,092	4,881	4,499	4,981	4,480	
Natural gasoline production	8,520	9,300	7,765	17,820	15,786	+ 13
Daily average	304	300	268	302	263	
Motor fuel production	62,607	67,180	56,288	129,787	114,471	+ 13
Daily average	2,236	2,167	1,940	2,200	1,908	
Gasoline yield, per cent	40.8	41.3	39.2	41.1	38.9	+ 2.2
Motor fuel stocks	86,010	79,700	78,254	86,010	78,254	+ 10
Days supply	43	40	43	43	43	
Motor fuel demand	56,259	61,980	52,820	118,239	105,722	+ 12
Daily average	2,009	1,999	1,821	2,004	1,762	
Fuel oil stocks	67,856	77,415	78,631	67,856	78,631	— 14
Daily supply	28	32	37	28	37	
Fuel oil demand	68,192	73,960	61,913	142,152	130,164	+ 9
Daily average	2,435	2,386	2,135	2,400	2,169	
Refinery still runs	135,055	143,075	126,993	278,130	260,154	+ 7
Daily average	4,823	4,615	4,379	4,714	4,336	
All refined stocks	225,106	234,100	225,495	225,106	225,495	....
Days supply	42	44	47	42	47	

*Unless otherwise stated all figures represent thousands of barrels.
†Domestic and foreign.

Economic Position of U. S. Petroleum Industry

February, 1945

	Normal	Actual	Per cent of normal
Drilling (wells completed)	4,290	3,910	91
Production (daily crude output)	4,870	4,780	98
Refining (daily still runs)	4,790	4,714	98
Stocks (crude and refined)	574,230	449,890	78
Price of crude (per bbl.)	$1.97	$1.22	62

Crude Prices by States for February, 1945

U. S. average	$1.22	Louisiana	$1.22
Texas	1.23	Arkansas	1.25
California	1.07	New Mexico	1.04
Oklahoma	1.17	Mississippi	1.10
Kansas	1.17	Illinois	1.37
		Other States	1.89

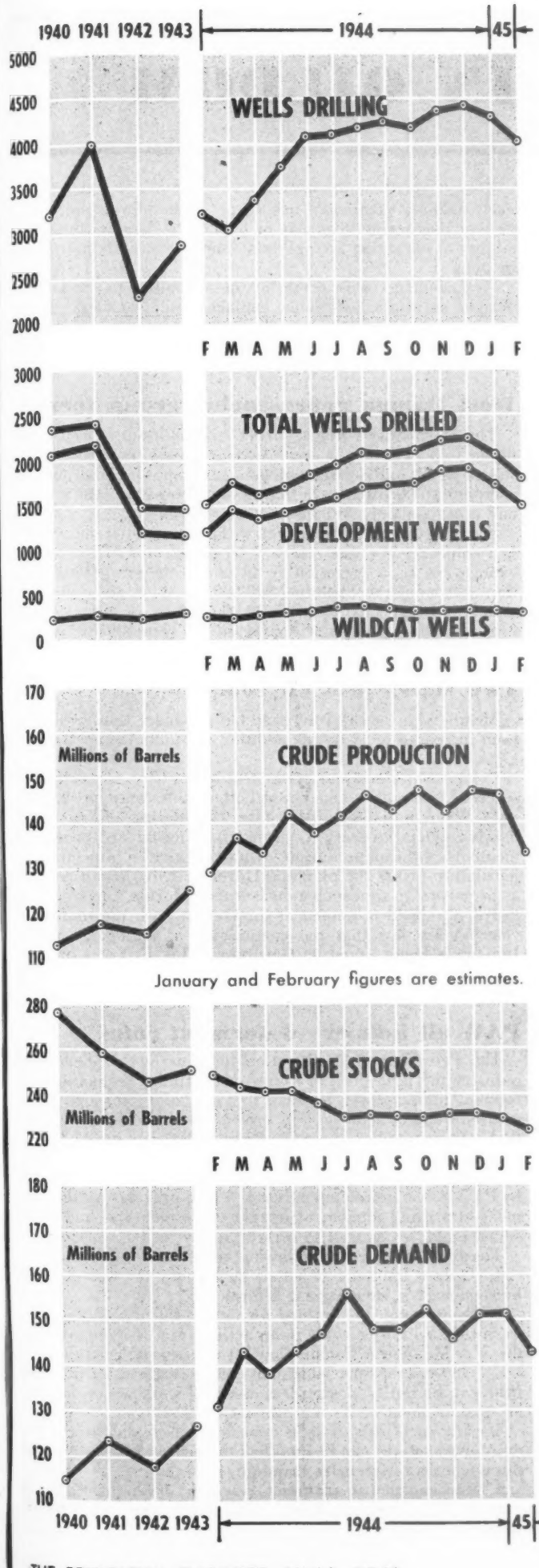
Basic crude prices

Oklahoma-Kansas (36 gt.)	$1.17
Texas Gulf Coast (36 gr.)	1.40
East Texas	1.25
West Texas (36 gr.)	1.04
Calif. Signal Hill (26 gr.)	1.11
Pennsylvania Bradford	3.00

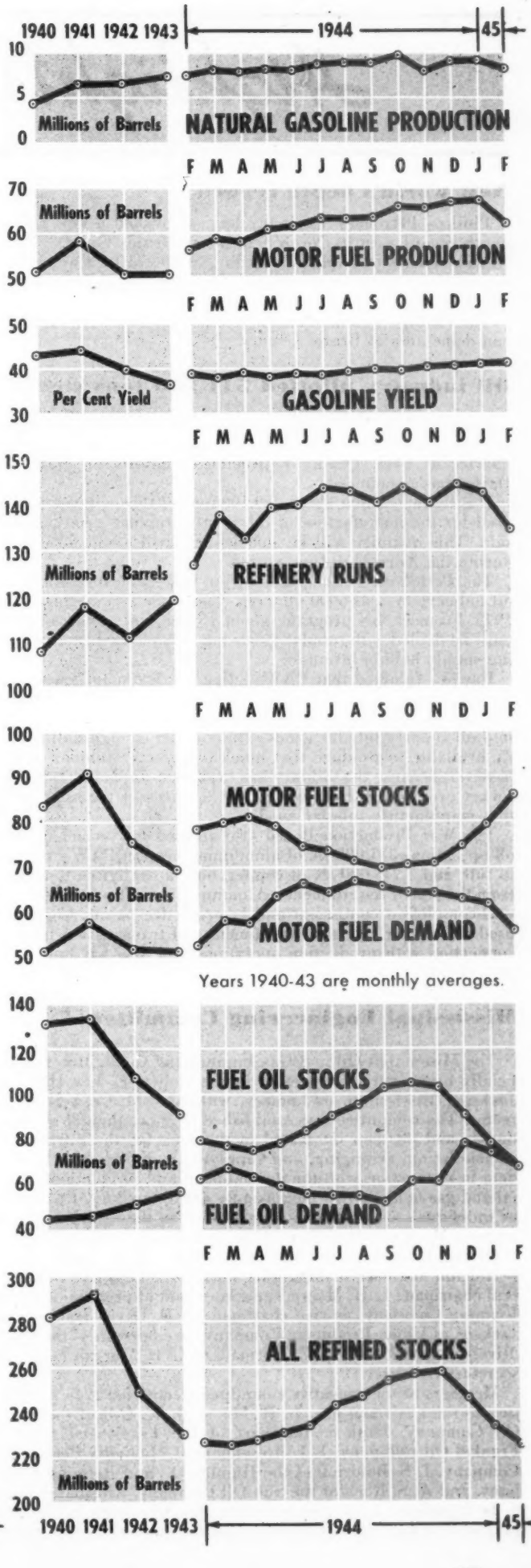
§No change since prices frozen. Prices do not include subsidies.

Drilling and Production Statistics by States

	Feb. 1945(p)	Jan. 1945(p)	Feb. 1944	This year to date	Last year to date	Per cent change
Total wells drilled	1,829	2,081	1,520	3,910	2,940	+33
Texas	558	552	383	1,110	698	+59
California	159	221	144	380	292	+30
Oklahoma	177	195	125	372	200	+86
Kansas	102	112	115	214	242	−12
Louisiana	67	81	50	148	94	+57
Arkansas	11	13	19	24	33	−27
New Mexico	34	41	45	75	68	−10
Mississippi	22	26	13	48	26	+85
Illinois	110	169	126	279	257	+ 9
Other States	589	671	500	1,260	1,030	+22
Wildcats drilled	314	346	278	660	554	+19
Texas	155	126	109	281	218	+29
California	14	22	12	36	28	+29
Oklahoma	26	34	22	60	41	+46
Kansas	26	35	35	61	63	− 3
Louisiana	8	16	13	24	26	− 8
Arkansas	7	4	7	11	10	+10
New Mexico	8	8	5	16	10	+60
Mississippi	8	10	7	18	18	....
Illinois	14	36	26	50	54	− 7
Other States	48	55	42	103	86	+20
Daily crude production	4,780	4,737	4,445	4,755	4,411	+ 8
Texas	2,162	2,111	1,921	2,135	1,908	+12
California	895	886	823	890	818	+ 9
Oklahoma	385	370	331	377	329	+15
Kansas	248	253	274	253	272	− 7
Louisiana	355	353	355	354	350	+ 1
Arkansas	82	81	79	81	79	+ 3
New Mexico	104	103	114	103	113	− 9
Mississippi	49	48	44	48	44	+ 9
Illinois	217	214	220	215	220	− 2
Other States	283	318	284	299	288	+ 4



January and February figures are estimates.



Years 1940-43 are monthly averages.

Highlights IN OILDOM

New world's depth record

Phillips Petroleum Company has established a new world's depth record with its No. 3 Schoeps in Brazos County, Texas. At last reports the well was drilling at 16,275 ft. The previous record was set by Standard Oil Company of California at a depth of 16,246 ft.

The Phillips well is in the E. M. Millican survey on the Millican dome area of Brazos County.

Oil industry allotted 511,500 tons steel

United States petroleum operators will receive 511,500 tons of carbon and alloy steel for oil operation during the second quarter of 1945, Deputy Petroleum Administrator Ralph K. Davies has announced.

It is estimated that about 260,100 tons of this material will be used for the manufacture of oil country tubular goods, Davies said. This quantity will be sufficient to drill about 6200 wells during the April-May-June period.

The Petroleum Administration for War has called upon the oil industry to drill 6900 oil wells during the second quarter of 1945. To meet this program, about 10 per cent of the oil wells must be drilled with tubular goods taken from the fast-diminishing supply held in inventory.

Davies explained that PAW, acting as a claimant agency for the oil industry, had requested that 287,000 tons of the 511,500 tons of steel allotted to petroleum operations be manufactured into oil country tubular goods. There is not enough mill capacity available to produce that much oil country tubular goods, however, because the military has expanded its shell, bomb, and rocket programs, which require the services of the same mills that manufacture tubular goods.

The War Production Board also allotted for second quarter oil operations 331,000 lb. of aluminum, meeting PAW's request in full, and 5,245,000 lb. of copper, only a negligible reduction from the stated requirements. Aluminum is used principally for well-completion equipment and in protective paints. Copper is used mainly for electrical equipment and transmission lines in connection with production operations and also has important uses in refining equipment.

Mississippi Engineering Committee

The Mississippi Oil and Gas Engineering Committee was officially organized at a meeting in the Robert E. Lee Hotel at Jackson, Mississippi, in January, with Alec M. Crowell as director. The committee was established by more than 35 oil producers and oil men interested in the area for the purpose of accumulating, arranging, and supplying members with factual data in connection with the development and production of the oil and gas fields in this increasingly active territory. Producers or individuals interested in membership on the committee may address Mr. Crowell at Box 347 at Jackson.

Officers elected for the first year include: D. V. Carter, chief petroleum engineer of Magnolia Petroleum Company, as general chairman; L. H. Moore, superintendent of production, Gulf Refining Company, as vice chairman; J. D. Davis, manager at Jackson of Union Producing Company, as chairman of the executive committee, and M. E. Norman, of C. L. Morgan et al., as secretary-treasurer.

Members of the executive committee elected for 1945 in addition to the chairman are: L. H. Moore, J. W. Gill of the Hunt Oil Company, Paul F. Barnhart of the Frank and George Frankel Oil Company, J. J. Bresenham of Magnolia Petroleum Company, J. S. Boldrick of the Humble Oil and Refining Company, and A. S. Rhea of the Sun Oil Company. Alternates were to be members of the general committee who were in the employ of The California Company and the Carter Oil Company.

The general committee includes at least one representative of each member company, and as fields are developed, special field or pool committees may be created to shoulder the responsibility of obtaining factual data from particularly active fields or pools.

Arrangements were made for the committee to employ J. K. Wright as senior petroleum engineer and two clerks for the office in Jackson. Plans were laid for the purchase of reservoir pressure gages and other equipment for obtaining factual field data, which will be reported monthly.

West Pampa repressuring group formed

The West Pampa Repressuring Association has been formed in the Texas Panhandle area. A cooperative agreement has been signed by 49 individuals, independent operators, and major oil companies. The area to be repressured consists of 14,320 acres and approximately 950 wells in Gray County.

Sour gas produced in the area will be treated to remove hydrogen sulphide. The gas also will be dehydrated. The project is expected to be in operation by the end of the year. Initial injection will be approximately 7,000,000 cu. ft. of gas a day. Ultimately it is expected to reach 30,000,000 cu. ft. a day.

Skelly Oil Company will provide the repressuring plant, it is announced.

Two states join oil compact

Membership in the Interstate Oil Compact Commission has been increased to 14 by the addition of Montana and West Virginia.

Commission headquarters at Oklahoma City, Oklahoma, has received information that several other states may join the compact. Wyoming is one of the states considering affiliation, commission officials report. Georgia and Florida are prospective members. Information from Atlanta is that sentiment in the legislature favors the plan and Governor Ellis Arnall is quoted as promising to sign such a measure. In Florida, Governor Millard F. Caldwell is quoted as anxious to push the uniform oil conservation law that the commission is urging. Joining by Indiana is being urged on Governor Ralph F. Yates by a proposal from O. L. Sturbois, president of the Indiana Oil and Gas Association.

PAW oil industry deferment rules

The Petroleum Administration for War has notified the oil industry the procedure to follow in obtaining occupational deferment for employes between the ages of 18 through 29. Increased requirements of the armed forces make it necessary that a large number of physically fit registrants under 30 years be inducted within the next few months, PAW says.

A plan of the Office of War Mobilization has been submitted by PAW to the petroleum industry, which provides for the deferment of a small number of irreplaceable technical and professional employes as well as certain highly skilled workmen.

The plan includes the following conditions:

1. Only a limited number of men under the age of 30 can be certified for occupational deferment.
2. No man can be certified for deferment unless he is doing work that is indispensable in an activity that is included within the War Manpower Commission list of essential activities.
3. No such indispensable man can be certified for deferment if he can be replaced from less essential work within the plant or establishment or by recruitment from without.
4. Any such man shall be considered as replaceable if a recruit or transferee can be qualified to perform his work through three months of intensive training.
5. Men engaged in planning, research, development, or production for postwar purposes, shall not be certified for deferment.

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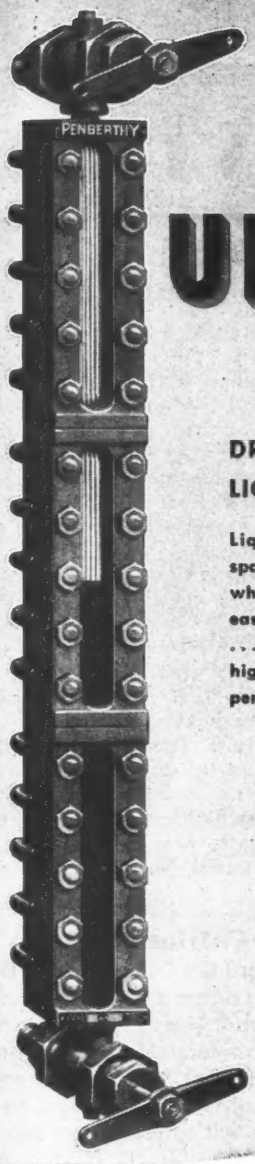

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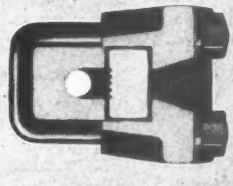

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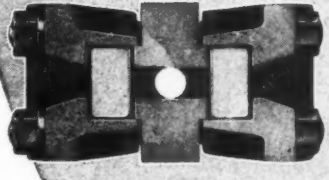
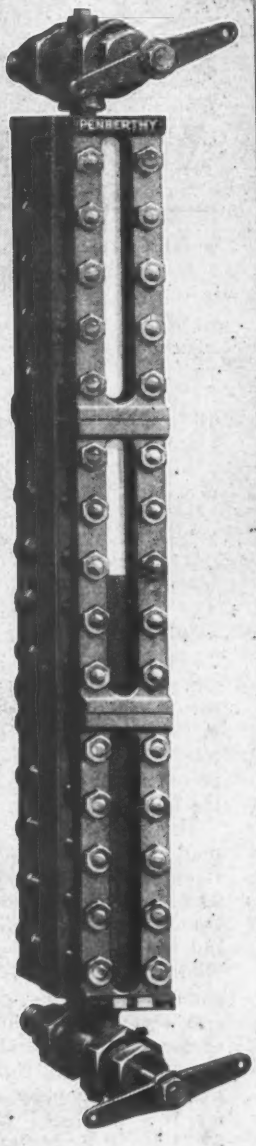
Used to observe color and density of liquids under high pressures, and/or temperatures. Construction is exceptionally rugged . . . similar to Reflex types.





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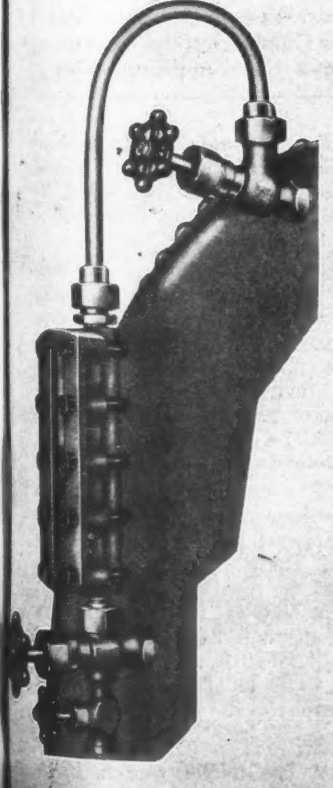

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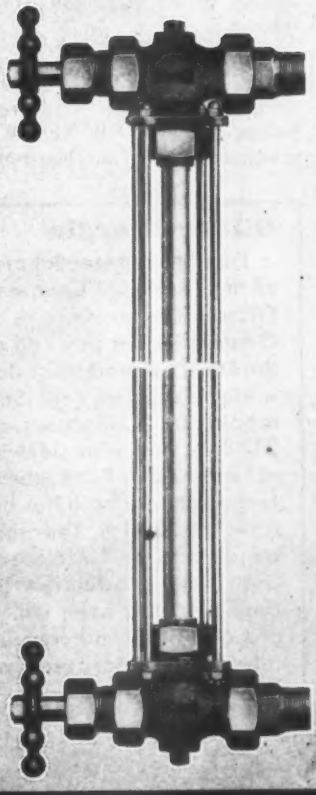

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PENBERTHY PRODUCTS

MAJOR *Oil Field* ACTIVITIES

▸ **OKLAHOMA.** Amerada Petroleum Corporation and Gulf Oil Company No. 1 Williams, NE NE SW, 27-6s-7e, west of Meade, western Bryan County, opens a new pool for Oklahoma. Tubing was run to 3064 ft. after plugging back from 3257 ft. The Bromide sand yielded, in an 18-hr. test, 177 bbl. of oil in the tanks. Crew has replaced the rotary tools with a production rig. This well indicates a possible rich oil pool for southern Oklahoma.

A third and shallower production zone, the Prue sand, has been discovered in the West Edmond pool of Oklahoma County. The sand was discovered in Sohio Petroleum Company No. 1 Patten-B CSW SW 27-14-4w. It showed 2,235,000 ft. of wet gas with 180 ft. of condensate on a test through 20 perforations between 6412-24 ft. First drilled to the Bois D'Arc at 6935, the well was backed up and completed in the Prue as a new pay zone for the four-county play.

Hanlon-Buchanan, Inc. has a good pool opener with No. 1 Heiring 18-19-2, Payne County. In 24 hr. the well flowed 97 bbl. of oil through a 1/16-in. choke. On other chokes it flowed as much as 213 bbl. a day. Bottomed at 4552 ft. the well is producing from the Misener sand topped at 4545 ft. Tubing pressure is 125 lb.

A second oil pool on the north end of the Nemaha trend, eastern Garfield County, has been opened by Con-Tex Petroleum Company and Frank M. Porter. It is the No. 1 Wolfe, NE SW SW 34-24-3w. It flowed at a rate of 40 bbl. of oil an hour from the Wilcox sand, total depth 4847 ft. When opened after cleaning itself into pits, the well flowed 75 bbl. of oil the first hour and settled to around 40 bbl. per hour through 2½-in. tubing.

▸ **ILLINOIS.** Edwards County has a pool opener with R. S. "Bob" Hays et al No. 1 Greathouse, 3 miles southwest of West Salem. The well, SW NE NW 23-1n-10e, is situated 2 miles southeast of the Maple Grove oil pool and 3½ miles southeast of the Bennington pool. The formation in this test is in the O'Hara limestone from 3247-54 ft. with total depth at 3320 ft.

Pure Oil Company opened an Aux Vases and McClosky lime pool for Wayne County with No. 1 S. J. Staley, 23-2n-7e. The discovery flowed oil on drillstem test at 3028 ft. It is situated a mile and a half north of the nearest production.

▸ **LOUISIANA.** Danciger Oil and Refining Company has opened a new pay in the North Cankton pool of St. Landry Parish, coastal Louisiana. It is No. 1 Pothier. Originally testing dry in the regular pay, the wildcat was plugged back and completed for a shallow gas discovery. When the well began to show water, however, it was deepened, and has been completed at 10,064 ft. for 113 bbl. of 65-gravity oil daily. This is approximately 400 ft. deeper than the regular pay zone.

The Atlantic Refining Company No. 1 Teche, 19-13s-9e, opened a new sand for the north Jeanerette pool of St. Mary Parish. It flowed 76 bbl. of 50.5-gravity condensate daily through 3/16-in. choke from 11,880-892 ft.

Another new pay zone has been opened in the West Tepetate pool of Jeff Davis County by Barnsdall Oil Company. This zone was found in the No. 3 Fusilier, which flowed 3,170,000 cu. ft. of gas daily through ¼-in. choke from 9272-76 ft.

▸ **NEW MEXICO.** Gulf No. 1 Andrews-State, 32-22s-38e, wildcat one and a half miles southeast of the initial producer in the Penrose section, southeast Lea County, has opened a new pool for that area. Bottomed at 6995 ft., the wildcat is producing at 6713 ft. It is flowing 38-gravity oil at the rate of from 10 to 15 bbl. per hr. The producer on drillstem test at 6713-6888 ft. had sweet gas of over 6,000,000 cu. ft. per day and considerable free oil.

▸ **KANSAS.** Helmerich and Payne, Inc. has opened a new pool for Kansas. It is the No. 1 Luck, NE NE, 13-8-22w. Assigned a potential of 328 bbl. a day by the commission, the well was brought in from the Lansing-Kansas City lime at 3500 ft.

▸ **MISSISSIPPI.** Humble Oil and Refining Company has opened a gas-condensate pool in Marion County with No. 1 Evans, NW NE 15-2n-18w. It is south of Columbia, in the edge of the state. Of particular interest is the relatively high gravity of the crude, 43 to 45 gravity. In the first 24 hr. the well flowed 108 bbl. of fluid. In a second 12-hr. test the well flowed 52.2 bbl. of fluid. Hole is bottomed at 9135 ft. and tubing set at 9067 ft. Testing is continuing.

▸ **TEXAS.** Magnolia Petroleum Company No. 1 Martin, 13-A47-PSL opens up a new pool in West Texas. The discovery is situated 5 miles south of the Mid-Continent Petroleum Corporation recent Devonian-Silurian discovery. It is south of the Fullerton pool of Andrews County. On a drillstem test at 3728-68 ft., 1040 ft. of fluid with the top 40 ft. showing clean oil was recovered. The oil is from the Devonian.

The opening of a Devonian lime pool in southwestern Andrews County by Stanolind Oil and Gas Company is virtually assured with No. 1-D University. The well flowed 341 bbl. of oil in 18 hr. after being treated with acid.

The third Devonian discovery for Ector County, West Texas, is the Cities Service Oil Company and Shell Oil Company TXL No. 1. The strike flowed 1911 bbl. of 41-gravity oil in 24 hr. during early tests. It is in 7-45-1, T&P Survey.

A strike of high-gravity oil for Shackelford County, west central Texas, is the P. S. Kendrick No. 3-C Lee. It opened a shallow oil pool 2 miles west of Albany. The discovery flowed 60 bbl. of oil daily on early tests from 11 ft. of sand at 980-991 ft. in the Tannahill of the upper Pennsylvanian.

A new gas-condensate pool has been uncovered in Freestone County, 3 miles southwest of Fairfield. It is The Texas Company No. 1 McKnight. It showed 14,500,000 cu. ft. of gas daily with 30 bbl. of 60-gravity condensate per 1,000,000 cu. ft. of gas. Production is from two zones, 8232-47 ft. and 8275-97 ft. The hole is bottomed at 8903 ft.

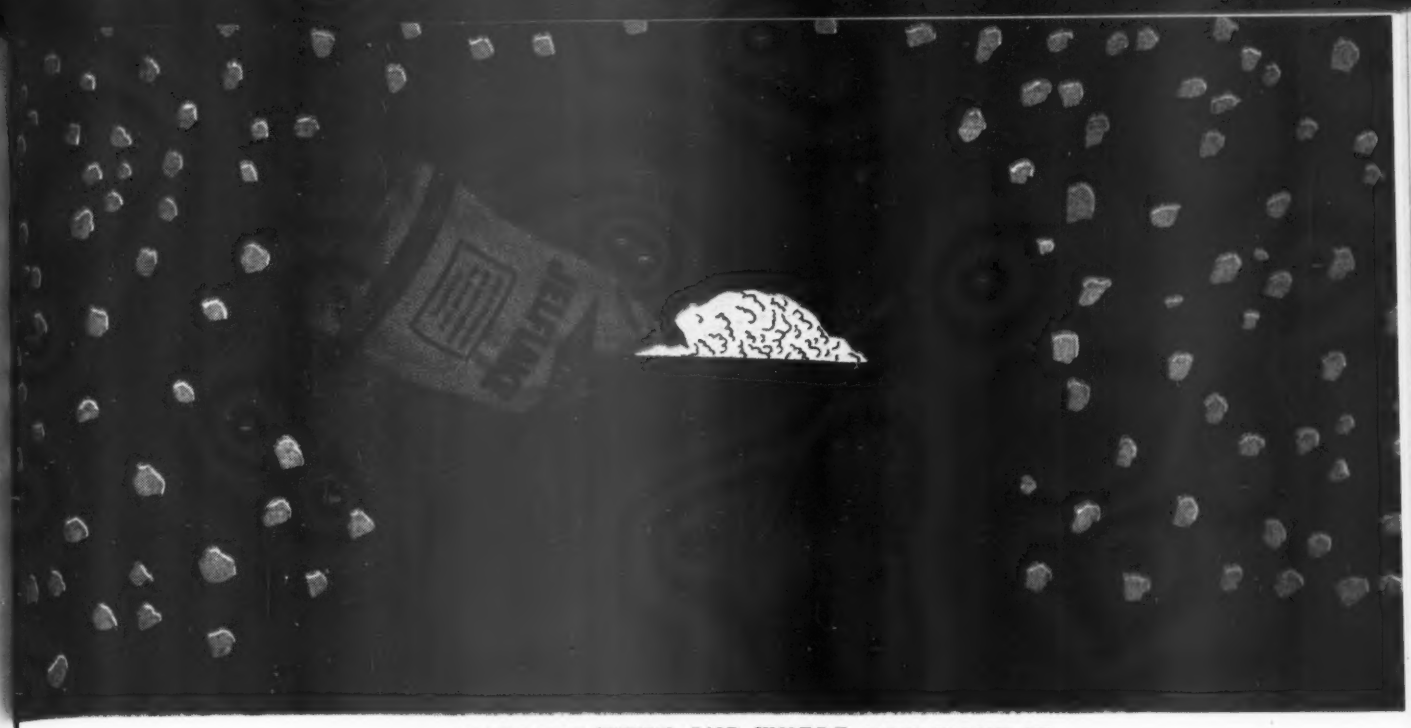
Eastern Throckmorton County has a new Caddo lime pool with the opening of James Stewart and Company of New York No. 1 Tharp. The well is 7 miles northeast of the town of Throckmorton. Bottomed at 4885 ft., the discovery was completed through 24 casing perforations from 4260-70 ft. and pumped 171 bbl. of oil in 24 hr. The discovery is 2 miles northwest of the Ewalt pool.

Oil for Georgia

Possible commercial production of the Tropic Oil Company No. 1 Gibson, Toombs County, will give Georgia its first pay and add it to the list of oil producing states. The wildcat, situated near Savannah, topped the Cretaceous at about 2178 ft. and with sidewall cores at 1869, 2178, 2241, and 2281 ft. found saturations. It has been shut down at 2300 ft. The wildcat will be taken to the Tuscaloosa section and if no production is found deeper in the hole, will then be plugged back and completion attempted in saturated formation.

Gas in California

Standard Oil Company of California has opened a new gas condensate pool with its No. 2 Calpak in the Sacramento River delta near the state capital. Situated on property of California Packing Company, the wildcat produced more than 14,000,000 cu. ft. of gas from 4810 ft. The discovery is 1½ miles from the Rio Vista gas field, one of the world's greatest dry gas fields. Wells previously drilled between Calpak and the Rio Vista field have been non-productive.



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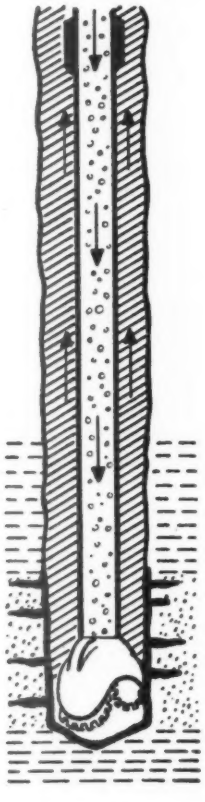

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MAJOR *Pipe Line* ACTIVITIES

▸ **WPB APPROVAL.** The addition of 4 compressor stations on the Tennessee Gas and Transmission Company pipe line from Monroe, Louisiana, to West Virginia has been approved by WPB. These additional stations will make possible the delivery of an additional 60,000,000 cu. ft. of gas daily into the Appalachian area. Cost of the stations is estimated at $5,000,000.

▸ **PROPOSED LINES.** Immediate authorization has been requested by Metropolitan Eastern Corporation of the Federal Power Commission for construction of a $23,500,000 pipe line from East Texas to Ohio to relieve a wartime shortage of natural gas in Ohio and nearby states. Metropolitan Eastern is a new concern with home offices in Wilmington, Delaware, and New York City. The proposed project would involve construction of an 18-in. line from the eastern Texas gas fields to an undesignated point in Ohio where the fuel would be resold to distributors. The corporation asked a prompt hearing with a view to beginning construction early in April. The line, 825 miles long, would be completed in October, in time to meet next winter's requirements for additional fuel. It would have a daily capacity of 140,000,000 cu. ft. of gas.

▸ **TEXAS ARTERIES.** Several pipe line projects are under way in various parts of Texas to provide outlets for new pools and to add to the state's ability to keep up oil production on the basis of demand. The Shell Pipe Line Company is starting construction of a 10-mile 6-in. line from the Wheeler station in eastern Winkler County to the company's new Devonian lime discovery in the TXL pool of western Ector County.

The Texas Gulf Coast area has a new products line under construction by Humble Pipe Line Company. The 79-mile 4-in. electrically welded carrier is being built from the Humble Oil and Refining Company's cycling plant at Katy to the Freeport plant of the Dow Chemical Company. The line will be used to deliver butane-propane-methane mixture to the Dow plant. It is scheduled for completion by the last of this month.

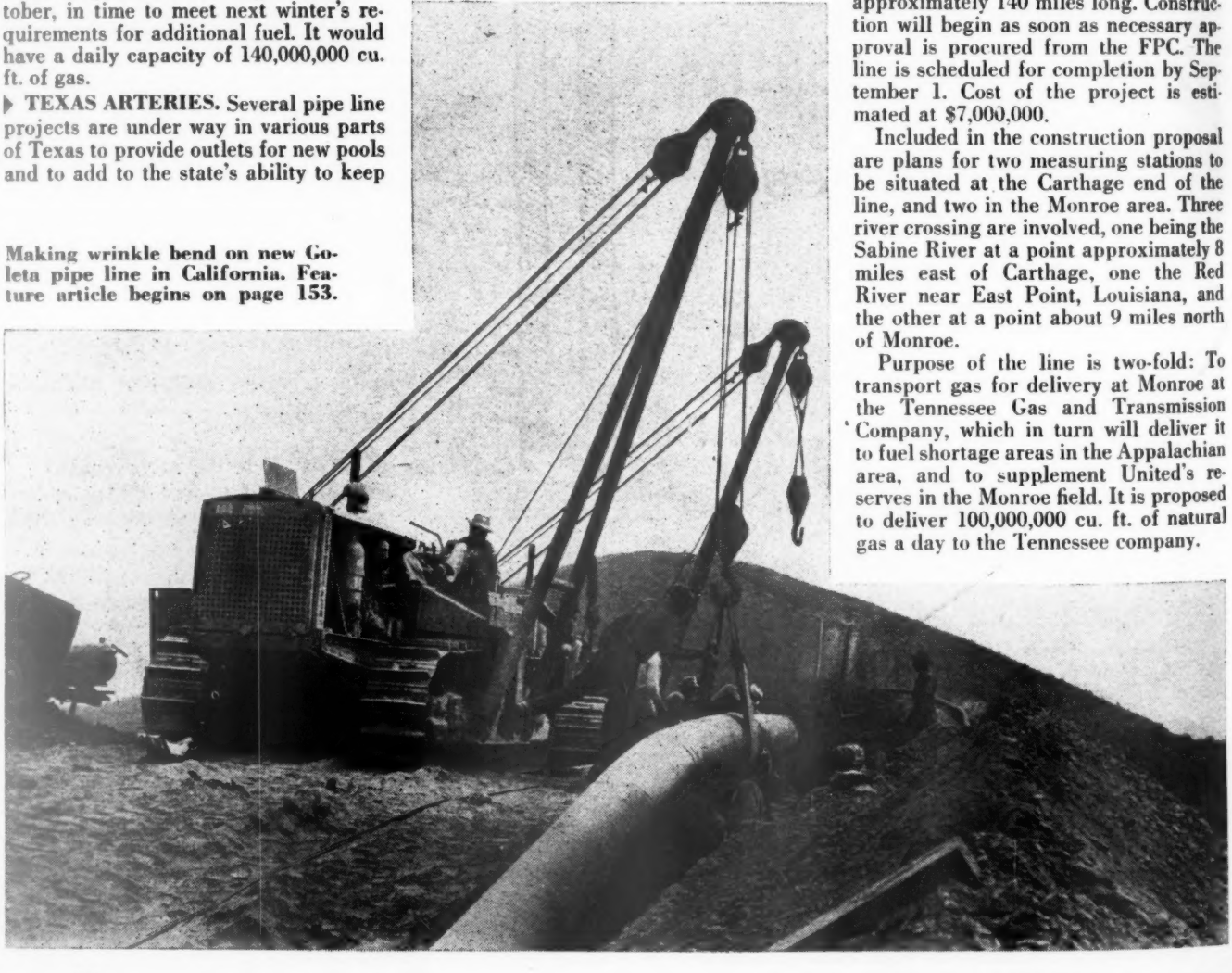
▸ **BELL LINES.** The Bell Western Corporation has completed its line extension from the Fargo pool in Wilbarger County, Texas, to the new Odell pool in the same county. The carrier is of 4½-in. pipe with gathering lines of the same dimension. The latter lines, however, are constructed of a lighter pipe to take advantage of the hilly country and to use gravity as much as possible.

Ben Franklin Refining Company, wholly owned subsidiary of Bell Oil and Gas Company, has purchased a tank and station site in Marshall County, north of Cumberland, Texas. A line has been constructed to these tanks from the Aylesworth pool where Ben Franklin has a gathering system. Oil is taken from the new tank station by truck and transported to the Ben Franklin refinery at Ardmore, Oklahoma. Ben Franklin has filed application for a permit to lay a 33-mile line from this area directly into Ardmore and requested permission to start construction of this line soon.

▸ **TOP PRIORITY LINE.** United Gas Pipe Line Company has been granted top priorities by WPB to construct a 24-in. main natural gas transmission pipe line from the Carthage gas field to the company's Sterlington compressor station near Monroe, Louisiana. R. H. Hargrove, vice president and general manager of the company who made the announcement, said that the line will be approximately 140 miles long. Construction will begin as soon as necessary approval is procured from the FPC. The line is scheduled for completion by September 1. Cost of the project is estimated at $7,000,000.

Included in the construction proposal are plans for two measuring stations to be situated at the Carthage end of the line, and two in the Monroe area. Three river crossing are involved, one being the Sabine River at a point approximately 8 miles east of Carthage, one the Red River near East Point, Louisiana, and the other at a point about 9 miles north of Monroe.

Purpose of the line is two-fold: To transport gas for delivery at Monroe at the Tennessee Gas and Transmission Company, which in turn will deliver it to fuel shortage areas in the Appalachian area, and to supplement United's reserves in the Monroe field. It is proposed to deliver 100,000,000 cu. ft. of natural gas a day to the Tennessee company.



Making wrinkle bend on new Goleta pipe line in California. Feature article begins on page 153.

give dependable, compact power to this modern minesweeper

The Minesweeper USS ARDENT, pictured here in her shake-down cruise, is 222 feet overall, with 32-foot breadth. Like many other wartime ships, she is powered with Baldwin diesels. Four eight-cylinder, four-cycle, Baldwin diesels, direct-coupled to Westinghouse direct current generators, are installed in pairs in two engine rooms.

The dependable and responsive performance of the Baldwin diesel is an important advantage in minesweeper service. An officer who had commanded one recently wrote, "In ten months of duty with the Pacific Fleet, including two major invasion campaigns, the dependability of the Baldwin engine was established beyond question." The Baldwin Locomotive Works, Philadelphia, Pa., U. S. A. Offices: Philadelphia, New York, Chicago, Washington, Boston, Cleveland, St. Louis, San Francisco, Houston, Pittsburgh, Detroit.

BALDWIN PRODUCTS Hydraulic presses, Testing equipment, Steel forgings and castings, Diesel-electric locomotives, Diesel engines, Metal plate fabrication, Rolled steel rings, Bronze castings, Heavy machine work, Crane wheels, Bending rolls, Plate planers, Babbitt metal, Alloy iron castings, Briquetting presses.

THE BALDWIN GROUP

BALDWIN

DIESEL ENGINES

MAJOR *Refining* ACTIVITIES

PREFERENCE TO SMALL PLANTS. Senator O'Mahoney of Wyoming has introduced into Congress legislation which, if passed, will give preference in sales of government royalty oil to small refineries without their own source of supply. The Interior Department now sells the royalty oil to the highest bidder. O'Mahoney told the Senate the "whole philosophy" of the act providing for leases on public domain was to encourage small enterprise.

CYCLING PLANT. A second cycling plant for the new Carthage Trinity area oil pool of Panola County, East Texas, is being planned by The Chicago Corporation. It will be situated on a 52-acre tract, 2 miles west of Carthage, Texas, in the A. Moorman survey. The corporation has mapped a 35-well drilling program on its 22,000-acre holdings.

The first cycling plant to be planned for this area, announced previously, is that of Rogers Lacy. His plant will be constructed on a 50-acre tract, 9 miles north of Carthage. A cycling plant situated in the Willow Springs gas pool of Gregg County, near Kilgore, Texas, will be dismantled and moved to the Panola County site. Work on this project will be started soon. Both Lacy and Lone Star Gas Company have purchased 30 acres near the railroad within the city limits of Carthage to be used for a loading rack.

LEASE TO SHELL. The City Harbor Commission is planning to construct a modern marine petroleum terminal, costing from $500,000 to $750,000 on a 10-acre tract off Jones Island near the harbor entrance, Milwaukee, Wisconsin. The plan, subject to approval by the city council, will be leased to Shell Oil Company for 15 years with a 10-year renewal option. Six large and 8 small gasoline and fuel oil storage tanks, to be constructed as soon as materials are available, will have a capacity of 10,000,000 gal. Shell operates its own tankers from the Chicago area. It was the first company on Jones Island. Other lessees are Clark's Super Gas, Socony-Vacuum, and Standard Oil companies.

MORE 100-OCTANE PLANTS. PAW has approved the building of five more 100-octane gasoline production plants, according to an announcement by Deputy Administrator Ralph K. Davies. Davies also disclosed that several more plants are now "under consideration." Plants to be built are, one for Leonard Refineries, Inc., Alma, Michigan; one for The Texas Company, Lockport, Illinois; two for Standard Oil Company of Indiana at Whiting, Indiana, and Sugar Creek, Missouri, and one for Shell Oil Company at Houston, Texas. Priorities for critical materials are being approved by WPB for only 4 of the plants. The one at Houston will not be built unless manpower is available. Private capital will finance the new facilities. The projects will cost approximately $78,000,000.

OIL SHALE PLANTS. Rifle, Colorado, has been selected as the site for a $1,500,000 oil-shale demonstration plant, Secretary of the Interior Harold L. Ickes, has announced. The new plant will be used as a proving ground for new oil source processes. Situated 7 miles west of Rifle, the plant will be built on government-owned land and will be operated in conjunction with an oil shale research and development laboratory to be constructed at Laramie, Wyoming. Selection of the Rifle and Laramie sites puts into operation essential parts of a 5-year synthetic liquid fuels program that embraces the production of liquid fuels from both coal and shale sources.

The Rifle plant will include a 200-ton-a-day shale mine, to be enlarged if necessary. It will have a 1½-mile aerial tramway to carry the shale from the mine to the plant. Crushing and retorting equipment of a capacity adequate to provide useful information on methods of operation and costs for private industry will be included. A shale oil refinery of pilot-plant scale will be added later. Other installations will include housing units and dormitory for about 125 employes, a small temporary office and laboratory building, a power house, a combination machine shop, warehouse and garage, a mess hall and kitchen and about a mile of access roads.

Investigation has revealed, according to Ickes, that of the estimated 92 billion bbl. of recoverable shale oil in the United States, nearly 48 billion bbl. are sealed in the shales of geologic formations around Rifle. The shales in this vicinity are expected to yield from 5 to more than 70 gal. of oil per ton.

The goal of the demonstration plant will be to cut a pattern enabling private industry to bring about economic utilization of American oil shales to supplement the diminishing sources of petroleum, Ickes disclosed.

CELEBRATES 25 YEARS. Pure Oil Company's Heath refinery in central Ohio completed a quarter of a century of progress on March 1. Situated on the outskirts of Newark, the plant has processed almost 75,000,000 bbl. of crude oil since beginning operation on March 1, 1920, records show. Output of the plant is now almost wholly going for war purposes, officials said. Gasoline, kerosine furnace oils, components for aviation gasoline, fuel oil, coke, and naphthas have been made since the beginning of the plant.

The seven employes who celebrated the silver anniversary with the plant as 25-year men were: Ray T. Schuler, Charles G. Swart, William E. Nicholaus, Carroll E. White, J. Burl Fluharty, Otto E. Adams, and Eugene E. McPherson.

ALLIED REFINERIES AT CAPACITY. The 66 refineries of the 22 United Nations, excluding the United States and Soviet Union, are now operating almost unanimously at capacity, according to a report made recently by PAW. During 1944 the 66 plants processed 1,450,000 bbl. of petroleum products daily. The statement said that the refineries of nationals abroad and those of our Allies, working under wartime difficulties unknown to the petroleum industry of North America, are contributing their full war share. Much of the operation of overseas refineries has been carried on despite problems ranging from food and drinking water shortages to attacks on the plants by enemy bombers and submarines.

The refineries have continued operations even though handicapped by greatly reduced inventories of maintenance and repair materials and being situated at several months' shipping distance from sources of replacement. Improvised refining techniques and makeshift equipment have been part of the operators' regular routine, the report said.

PLAN EXPANSION. Phillips Petroleum Company is planning a new $7,000,000 refinery project in the Northwest Texas Panhandle fields, according to recent reports from that area. Particulars of the plan were not disclosed.

PLANT TO EXPAND. The Defense Plant Corporation has given its permission for construction of additional facilities at the Continental Carbon Company plant at Sunray, Moore County, Texas. The additions to be made to the plant will cost about $600,000, according to Continental Carbon, headquarters of which are in New York City.

CO-OP BUYS REFINERY. The eleventh refinery in the United States to be bought by a cooperative wholesale organization has been acquired by the Consumers Co-operatives, Associated, Amarillo, Texas. It is the Motor Fuels Corporation, Levelland, Texas, purchased for approximately $750,000. The refinery has a daily capacity of 5500 bbl. The purchase includes plant and facilities embracing modern topping and cracking units, an ethyl blending plant, perco desulphurization unit, 150,000-bbl. storage space, and 120 acres of real estate.

The plant is situated in Hockley County, West Texas Permian Basin, and takes crude from the Slaughter pool, 14 miles southwest through a direct pipe line. The line was not included in the sale. More than $440,000 of the $750,000-purchase price was raised by more than 1500 farmers, other individuals and cooperative associations. The rest was financed through a loan from the Houston Bank for Co-operatives.

THE Petroleum Engineer

MARCH, 1945

GEOPHYSICAL WORK IN PARAGUAY INDICATES EXTENT OF EXPLORATION IN SOUTH AMERICA

By **WALLACE A. SAWDON,** *Pacific Coast and Foreign Editor*

EXCLUSIVE WITH exploratory drilling active in the present producing countries of Venezuela, Colombia, Ecuador, and Peru, and with the continued efforts of Argentina to make that country self-sufficient in oil production, increased attention is being paid to the petroleum possibilities of the South American continent as a whole. Bolivia has produced some oil for many years and Brazil has recently obtained a little commercial production. Drilling is active in Brazil in the coastal areas along the Atlantic Ocean south of the bulge and exploration has been going on in Chile for several years. The most recent point of interest, however, is that part of the Gran Chaco lying in western Paraguay where geophysical exploration has just begun.

As indicated by the accompanying map, the Gran Chaco extends from northern Argentina into western Paraguay. The portion in Paraguay is known as the Chaco Boreal and covers some 100,000 square miles. It was the scene of the Chaco War between Paraguay and Bolivia, which lasted from 1932 to 1935. The area in general is flat wooded country and in the wet season the rivers are subject to floods that inundate vast areas and, in the more easterly part, leave lakes and swamps that persist for most of the year. The Pilcomayo River is the boundary between Argentina and Paraguay. Along the Rio Paraguay are several plants where tannic acid is made from the Quebracho Colorado, a very hard redwood.

The geophysical work is being conducted in an area that is flat, marshy, silt-covered and that bears forest, long coarse grasses, and scrub. Union Oil Company has contracted with the Paraguayan government to explore for oil on a tract comprising more than 54,000,000 acres in this Chaco region and Western Geophysical Company has been retained by Union to perform the necessary geophysical work. No wells have ever been drilled in the Chaco of Paraguay and inasmuch as there is a lack of rock outcrops it will depend entirely on geophysical prospecting to procure data on the thickness of the sedimentary sections and structural information on which to base a test well. At the present time seismograph surveys appear to be the most advantageous and will probably be employed throughout the entire project. Should other types of geophysical work become desirous they will be used.

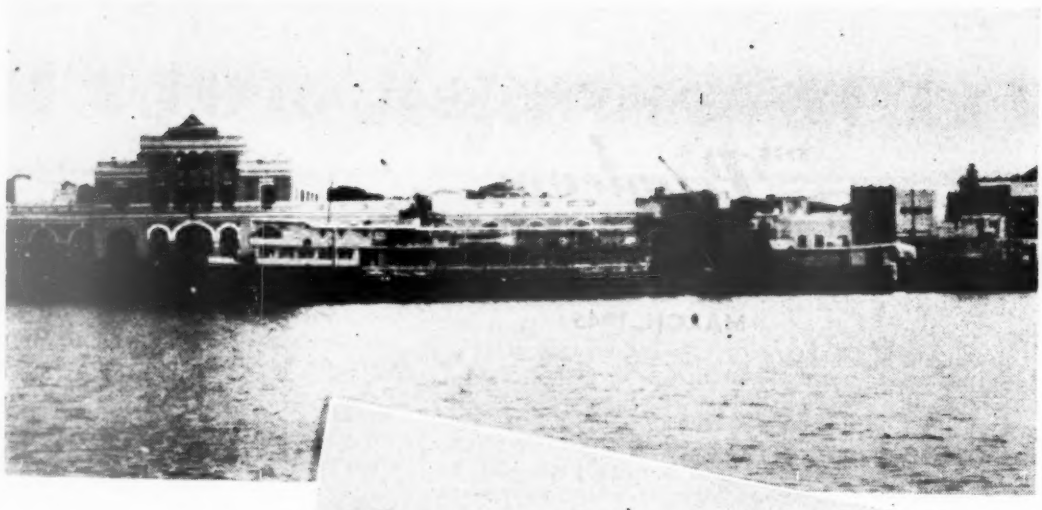
The prospects for striking oil are, of course, uncertain. As there are a number of oil fields located along the east flank of the Andes in Peru, Bolivia, and Argentina, it is entirely possible that other fields will be found in the area east of the Andean foothills and it is in this general area that Union is prospecting now. This general area has also been given serious consideration by the Y.P.F. of Argentina in their search for oil in the western part of their own country, their operations being confined, of course, to south of the Pilcomayo River.

The location of the Paraguayan Chaco with reference to the producing fields of Bolivia and Argentina, is shown on the accompanying map. With the exception of the great Comodoro Rivadavia field, which lies along the Atlantic coast southwest of Buenos Aires, all fields in Argentina are located along this Andean belt.

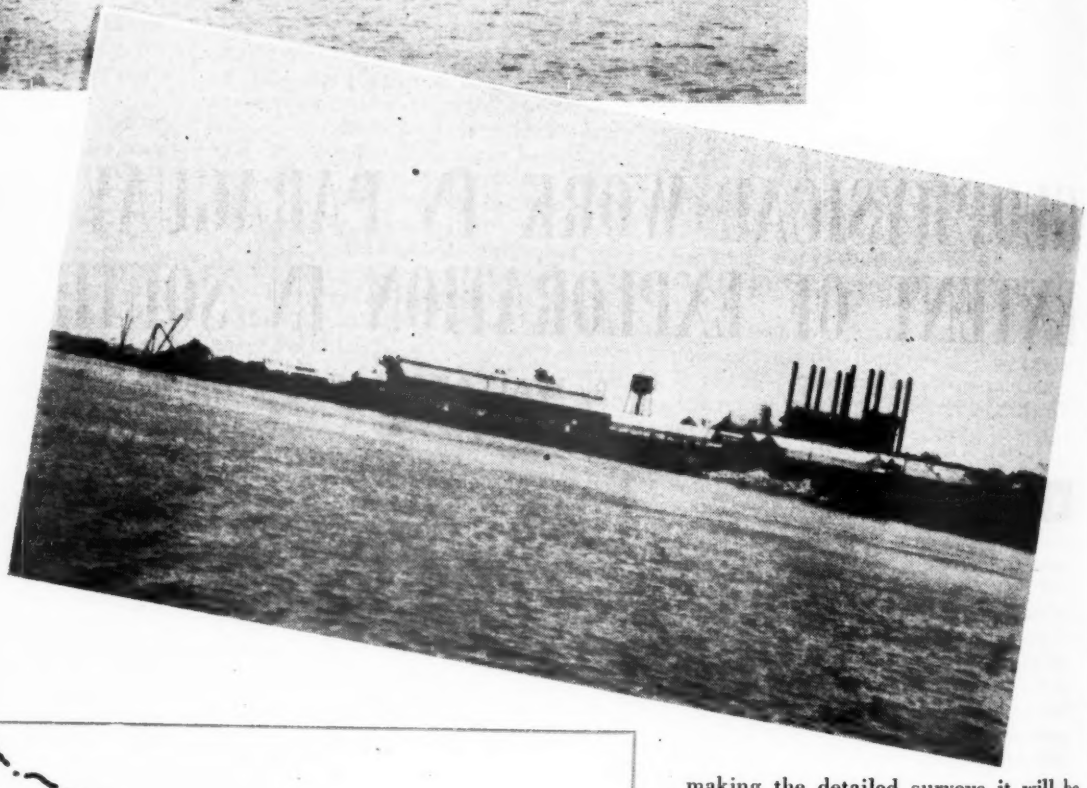
▸ **Seismograph operations.** One seismograph party is now actively surveying and a second crew is being assembled. The work had been in contemplation for some time and Western Geophysical Company had equipment in Peru for several months waiting for the discussions and arrangements to be completed. On verbal agreement after final decision regarding details of location of work and operating arrangements had been made, the equipment was immediately put en route. If the geophysical arrangements had been "made from scratch" at the time the agreement was reached it would have delayed the field operations from 4 to 6 months because of the time necessary to accumulate and ship the equipment under conditions as they exist today.

Food, supplies, and all other requirements for the conduct of seismographic operations have to be transported by boat from Asuncion to Puerto Casado on the Paraguay River and then by rail and truck to the field camp. A fair east-west road traverses the area to be surveyed but with the exception of a small colony and a few army camps there are no other settlements in the area. Water will have to be obtained from wells drilled at camps as they are established, the water supply thus established being used for operations as well as for drinking.

Plans now being followed provide for running a seismograph line along the east-west road. The main camp has been set up near this road at about the halfway point and operations will be controlled from there. Data obtained from work along the east-west line will serve to establish the major syncline structural features and to indicate any anticlinical reversals that may be present. Upon completion of this seismograph line, detailed work will be done in local areas that show up most favorably. In



Custom House and dock at Asuncion from which equipment is transported by boat to Puerto Casado.



A tannic acid plant along the Rio Paraguay.

making the detailed surveys it will be necessary to cut through the heavy growth and it is possible that bulldozers and other road building equipment will have to be employed.

Union Oil Company, operating in the capacity of a contractor for the Government of Paraguay to develop the petroleum resources, contemplates actual drilling within 18 months. The company's head office will be at Asuncion and work will be handled by Chester Castle as technical manager.

The seismograph crew now operating employs from 2 to 3 Paraguayans to each American. These serve as helpers and laborers but there are also trainees with engineering education working with the parties and they will be given responsible positions as soon as they acquire the necessary experience. In addition there is the camp personnel, which is also composed of Paraguayans. Buildings will be constructed at the headquarter camp and will include housing facilities for the personnel.

Present information indicates that good seismograph records are being obtained to relatively great depth and there is now no question of the workability of of the area by seismograph. ★★★

REVIEW OF 1944 HIGHER COURT DECISIONS OF IMPORTANCE TO OIL AND GAS PRODUCERS

By **LEO T. PARKER**

EXCLUSIVE DURING the last few months the higher courts have decided unusual and important phases of law relating to oil and gas producers. In many cases these new decisions have reversed the older law; however, in other instances technicalities of modern law have won the lawsuits.

Few executives have sufficient spare time to study and acquire legal knowledge designed to enable them to recognize indications of adverse suits and forestall contract litigations. For this reason a majority of officials perform their duties without great regard to *modern* law.

Therefore, in this article we shall review late and leading higher court decisions designed to assist readers in avoiding similar legal controversies. Moreover, the cited modern cases may be advantageously utilized to win unavoidable suits.

▸ **Lease is altered.** Modern higher courts consistently hold that any alteration renders a written instrument void if the alteration so changes its terms as to give it a different legal effect from what it originally had, and thus work some change in the rights, obligation, interests, or relations of the parties. It is immaterial whether this effect is brought about by interlineation, substitution, change of words or erasures, or by deleting some material provision of the instrument.

For illustration, in Ruwaldt v. W. C. McBride, 57 N. E. (2d) 863, reported December, 1944, suit was filed to stop drilling operations on a tract of land, it being contended that the lease was rendered void by certain alterations.

During the trial it was shown that after a lease was signed and executed by a widow and son, there was written in longhand on the face of the lease beneath the description the following: "If no well be commenced within (60) sixty days on adjoining property this lease shall be void from the following date—2-14-41, or void 5-14-41;" and on the left-hand margin appeared "(3-14-41.)" Through these words was drawn a line in ink, which would indicate the clause had been eliminated by "scratching out."

It was not disputed that this clause, or its elimination, was inserted upon the face of the lease without the knowledge of the widow or her son.

Therefore, the higher court held the lease void, saying:

"Such an alteration renders the instrument void."

▸ **Law of usury.** Modern higher courts hold that whether usury exists in a contract depends on the dominant purpose and *intention* of the parties. Moreover, the contract will be construed as a whole in the light of attending circumstances.

For example, in Standard Supply and Hardware Company, Inc., v. Christian-Carpenter Drilling Company, 183 S. W. (2d) 657, reported December, 1944, it was shown that an oil well drilling contractor and oil producer purchased $54,079.53 worth of oil well supplies from a supply company. It seems that the contractor was unable to pay the account and when there were 7 outstanding, unpaid invoices, the seller notified the contractor that unless the account was promptly paid a financing charge of 10 per cent would be added to each invoice.

An expert lists cases arising from oil and gas disputes and interprets their effect on the industry.

The contractor acquiesced in the imposition of the 10 per cent financing charge, and executed 7 promissory notes covering, respectively, the amounts of the respective invoices with the 10 per cent finance charge added. Each note was dated as of the date on which the invoice became past due and bore interest at the rate of 6 per cent per annum. Thus the contractor had agreed to pay 16 per cent interest, which is illegal and usurious.

Later the contractor sued the seller for double the allegedly usurious interest exacted of him by the seller. This suit was based upon a state law that specifies penalties for anyone who charges illegal rates of interest.

The seller contended that the 10 per cent financing charge was in reality the differential in price between the merchandise when paid for currently, and when bought on extended credit, to be paid for at some indefinite time. As the testimony proved, however, that the seller had added the 10 per cent service charge *after* the sale was made, the higher court held the seller liable for usury. This court said that a seller may legally charge more for merchandise sold on credit than for cash. The court held, however, that *after* a purchaser is in default for money due on a current amount, and the seller undertakes to add retroactively to the current price and collect interest retroactively, he violates the usury laws.

▸ **Lease not sale of oil.** Frequently lease contracts have been held by the higher courts to be legal sale contracts; however, this rule of law is not applicable unless the intent of the lessor is clear.

For example, in Commissioner of Internal Revenue v. Felix Oil Company, 144 Fed. (2d) 276, reported October, 1944, it was shown that a property owner leased certain land for the term of 20 years and so long thereafter as oil or gas might continue to be produced. This agreement has since remained in full force and effect. It is in form a lease, and save in one particular its provisions are very similar to those of the typical oil and gas lease. The peculiarity lies in this: Instead of retaining a gross royalty, the lessor was to receive 50 per cent of the "net profits." The term "net profits" was the proceeds of sale of the oil less the expenses of the lessee in drilling, pumping, storage, and the like, less also a number of other items such as state and county taxes, insurance, and general operating costs. Although the agreement recites that it was given in consideration of the sum of $10, the actual amount paid to the lessor at the time of execution was $150,000.

It is interesting to observe that when interpreting this lease, the higher court held that although the lease provided for the lessor to receive 50 per cent of the net profits, instead of a gross royalty, this did not establish that the purported lease amounted to an absolute sale of the oil.

In other words, the contract was a legal lease, notwithstanding the inclusion of this special clause.

On the other hand, see Watkins v. Slaughter, 183 S. W. (2d) 474, reported January, 1945. In this case it was shown that a deed for land contained a "reservation" of mineral "royalty rights" to the seller. The higher court construed this reservation not to include reservation of bonuses or rentals, but only of interest in the oil, gas or minerals paid, received or realized as royalty.

Another important point of law involving oil leases relates to partnerships.

In Sklar v. Kahle, 16 So. (2d) 896, reported April, 1944, it was shown that partners are the co-owners of a certain producing oil, gas, and mineral lease (as well as certain drilling and operating machinery and equipment on the premises) that is being operated by them as a joint adventure or co-partnership. One of the partners filed a suit to have the partnership liquidated and its assets partitioned on the ground that the other partner has failed and refused to pay his share of the expenses of operation in accordance with their agreement.

The higher court held that partnership property cannot be partitioned or the affairs of the partnership liquidated until

after the partnership has been dissolved. The higher court held that the lower court should not have appointed a receiver. This higher court said:

"The judgment appointing a receiver to administer the affairs of the partnership is annulled and set aside."

▸ **Directors have broad powers.** Modern courts hold that the questions of policy in management of a corporation's affairs, expediency of corporation's contracts, adequacy of consideration for such contracts, and lawful appropriation of corporate funds to advance corporate interests, are left solely to its directors' honest and unselfish decision.

For example, in Blaustein v. Pan American Petroleum and Transport Company, 50 N. E. (2d) 705, reported September, 1944, it was shown that a subsidiary of an oil corporation owned the majority of a third oil corporation's stock. The testimony proved that the subsidiary consistently pursued an oil exploration program and purchased considerable oil lands in Texas with its own funds, and independently of the third corporation. The third corporation's directors decided to build an oil refinery in Texas.

A suit was filed and the court was asked to impress the properties of the subsidiary company, it being contended there was a constructive trust in the third corporation's favor because the parent corporation had usurped profitable business opportunities of the third corporation in purchasing properties and selling oil therefrom to the third corporation at a profit.

The higher court refused to comply with this request on the ground that there was no evidence what these properties were or that the third corporation had any tangible expectancy. This court said:

"The rule which permits a court to impress with a constructive trust property which is the product of an appropriation of a business opportunity by a corporation director or officer or a majority stockholder owing some form of fiduciary duty, is *not* satisfied by proof that *after* the property is appropriated it *occurs* that it would have been useful in the corporation's business."

▸ **Fair Labor Standards Act.** The Fair Labor Standards Act is applicable to all employers who transact interstate commerce business. This federal law clearly specifies minimum wages and time and one-half for overtime, which must be paid to all employes. Failure of an employer to comply with this federal law entitles the employe to sue and recover double back wages, plus heavy penalties, and lawyer fees of $500 and more. In view of these facts all employers should realize that the Fair Labor Standards Act is applicable to employes who *process, manufacture* or *handle* goods *destined* for interstate commerce.

Obviously, however, the employe must prove that the merchandise he handles is shipped in interstate commerce, or he is not entitled to a recovery.

For illustration, in Harland Oil Company v. Pattison, 153 Pac. (2d) 622, reported January, 1945, it was disclosed that an employe sued his employer to recover back wages, penalties, and lawyer's fees. The employe contended that he was entitled to wages under the Fair Labor Standards Act because he was a roustabout on producing leases of his employer. It was shown that there was pumped from the lease 55,000 bbl. that went into the Cosden Pipe Line Company at Hominy, Oklahoma, and from there it went to the Mid-Continent refinery at Tulsa, Oklahoma.

The employe did not prove that the oil delivered to the Mid-Continent refinery was shipped or piped to purchasers or users in other states. Therefore, the higher court refused to hold the employe entitled to wages under the Fair Labor Standards Act. This court said:

"Are we permitted to supply the lack of this testimony by saying, as a court, it is well known that employer or Mid-Continent refinery at Tulsa, Oklahoma, send all or a part of the oil involved into interstate commerce? This must be answered in the negative."

▸ **Law of independent contractors.** There is a vast legal difference between a legal employe and an independent contractor. For example, among other legal differences, an employer is not required to pay such taxes as social security, state workmen's compensation, unemployment and the like on an independent contractor. Moreover, an employer is not liable in damages for injuries to persons or property caused by an independent contractor. Neither is an employer liable in damages or for payment of compensation to an independent contractor killed or injured while performing his work.

For illustration, in Langley v. Findley, 19 So. (2d) 908, reported April, 1944, it was shown that a man named Findley purchased an oil well that had ceased to produce. He desired to test it for production and effected an agreement with a man named Langley who obligated himself for the consideration of $1000 to clean out the well and set 4-in. liner at a depth of 2430 ft. unless work was stopped at a lesser depth. It was thought that the well could again be made to produce at a depth of not more than 2430 ft. Langley was obligated to supply all material, machinery, and labor necessary to discharge his part of the contract.

One day an employe of Findley went to the well, and while Langley was doing some special work for Findley's employe Langley's derrick over the well, on account of excessive strain upon it, collapsed and fell upon Langley, killing him instantly. His widow sued Findley for compensation.

As Findley was an independent contractor, however, the higher court refused to render a verdict in favor of the widow, saying:

"The deceased was entirely capable by many years' experience of performing any work or task arising from the drilling and operation of oil wells. . . . We are clear in the opinion that Langley met death because of his own carelessness and negligence in putting too much strain upon the derrick."

▸ **Partners share in profits.** Frequently, the courts have difficulty in determining whether a verbal contract between two parties for development of oil leases is a partnership or a mere employment contract. If the court decides that it is a partnership agreement both parties may share equally in the profits, but if it is an employment agreement the employe is entitled to receive only fair and reasonable *wages*, without regard to the profits earned by the employer.

For instance, in Miles v. Fredenhagen, 16 N. W. (2d) 117, reported December, 1944, it was shown that a man named Miles sued a man named Frank and asked the court to compel the latter to pay him one-half of the profits derived from an oil venture. Miles testified that he had entered into an oral agreement with Frank to prospect for and produce oil or gas in the Bloomingdale oil and gas field, and that it was agreed each should receive a share of the net profits therefrom. Miles made trips, devoted time to negotiating oil and gas leases, procured leases, negotiated for and procured an agreement from well drillers, and a producing well was drilled from which Frank has received and kept large sums of money *without* accounting to Miles for his share.

Miles contended that he had *not* made a partnership agreement with Frank, but that he had merely employed him and that he owed him nothing more than a reasonable salary for the time he had worked.

After reviewing all testimony the higher court held that Miles was a legal partner and entitled to share in the profits. The court said:

"It is reasonable to believe that plaintiff (Miles) would not have devoted so much time and expense in obtaining leases, raising funds to drill wells, arranging for contracts, using his own transportation on a considerable number of trips in Illinois and to Michigan without some agreement to share in the profits."

★★★

Against Big Inch conversion

Action designed to prevent transportation of oil to the East through the Big Inch pipe line after the war was taken recently by the Arkansas House of Representatives. The resolution urged that the five Southwest oil-producing states combine to stop the oil movement at the close of the war.

The resolution, introduced by Representative Chambers, said that unrestricted flow of oil through the line after the war would drain the Southwest of its resources, curtail industrial development, and cause loss of taxes.

Louisiana, Texas, Mississippi, and Oklahoma were invited to join Arkansas in a move to impose restrictions upon exportation of oil and gas.

THE STORAGE OF BUTADIENE AND ISOBUTYLENE*

EXCLUSIVE ▸ **Abstract.** The results of the review and research reported herein on butadiene and isobutylene indicate the following:

A. Where precooling is unnecessary, the compounds should be stored at a temperature of about 32°F. and corresponding working pressures of about 3 or 4 lb. per sq. in. gage. This conclusion is supported by the following facts: (1) The loss of product at about 32°F., through dimerization and/or polymerization, is negligible; (2) storage at about 32°F. results in the lowest total annual operating cost as well as the lowest initial cost of the storage plant; (3) the amount of steel required for the containers at the recommended storage temperature of 32°F. is less than one-half of the steel required for containers in which the compounds are stored at ambient temperatures.

B. Where precooling is required, the most economic storage temperature should be determined according to procedure suggested under "Filling Refrigeration Costs" in the original bulletins.

C. The containers should be of maximum size for the total capacity involved, because within the range of capacities considered for the synthetic rubber plants and for the producers of raw materials, the larger the container size the lower the cost per unit of product stored.

☆☆☆

The war with Japan cut off American supplies of crude rubber. The war program necessitated that a material be produced that would have the properties of rubber. The synthetic rubber industry was the outgrowth of this emergency. This new industry involved the mass production of chemical compounds that prior to the war had had little or no commercial usage in this country. Butadiene, isobutylene, styrene, and acrylonitrile were the new products that must be manufactured, stored, shipped, and used in the processes of manufacturing synthetic rubber. These new commercially important substances had never been stored in large quantities such as were entailed in the war program. The lack of previous experience in the storage of these important compounds occasioned the development of the correct physical and chemical properties of these substances, for these properties affect the safe and economical storage of them. Factors involved in the solution of storage problems were: Container materials, suitable protective coatings, proper storage conditions of temperature and pressure, and the most economical type of storage plant from the standpoint of initial costs.

This article relates only to the storage of butadiene and isobutylene.

▸ **Physical properties.** Physical properties of butadiene and isobutylene are as follows:

Properties		Butadiene	Isobutylene
Chemical formula		C_4H_6	C_4H_8
Molecular weight		54.09	56.06
Normal physical state		gas	gas
Boiling point, °F. at 1 atm.		23.54[1]	22.28[1]
Melting point, °F. at 1 atm.		−163.67[1]	−232.2[1]
Critical temperature, °F.		325.7[2]	292.5[2]
Critical pressure, lb. per sq. in. abs.		...	582[3]
Gas constant "R" in ft.-lb. per °R. per lb.		28.6[3]	27.6[3]
Latent heat of vaporization, B.t.u. per lb.		175.75[1]	158[4]
Specific heat of gas "Cp" B.t.u. per lb. per °F. at 60°F.		0.332[1]	0.366[2]
Ratio of specific heats Cp/Cv at 60°F. and 1 atm.		...	1.11[5]
Specific heat of liquid, B.t.u. per lb. at 60°F.		0.551[1]	0.555[6]
Specific gravity of gas at 60°F. and 1 atm. (Air=1)		1.877[1]	1.977[7]
Specific gravity of liquid at 60°F. (Water=1 at 60°F.)		0.627[1]	0.601[7]
Lb. per cu. ft. of liquid at 60°F.		39.0[3]	37.7[3]
Limits of inflammability in air (per cent by volume)		1.6-11.5[1]	1.7-9.0[1]
Vapor pressures, lb. per sq. in. abs. at:	140°F.	114.7	123.0[1]
	100°F.	64.7	65.1
	70°F.	37.7	38.7
	32°F.	17.65	18.78
	0°F.	8.5	9.45
	−40°F.	2.85	3.3
	−100°F.	0.359	0.38

Note the following charts:
Chart 1. Temperature-specific gravity relationships of liquid butadiene.
Chart 2. Temperature-latent and specific heat relationships of butadiene.
Chart 3. Temperature-vapor pressure relationships of butadiene.
Chart 4. Temperature-specific gravity relationships of liquid isobutylene.
Chart 5. Temperature-vapor pressure relationships of isobutylene.

▸ **Chemical properties.** *Butadiene.* The most prominent chemical property of butadiene is that of dimerization and/or

*Prepared especially for *The Petroleum Engineer* by the research staff of the Pittsburgh-Des Moines Steel Company. For more detailed information, reference is made to that company's bulletins 7.381C on butadiene, 7.401B on isobutylene, and 7.427B on physical properties.

TABLE 1
Cost comparisons for 300-ton storage capacity

Type of container	"0"	"OR"	"OW"	"10"	"10"	"45"	"45"	"100"	"100R"	"100W"	"110"	"110"
Storage temperature, °F.	140	100	100	70	32	32	24	140	100	100	70	32
Working pressure, lb. per sq. in.	100	50	50	23	3	3	0	100	50	50	23	3
Vapor pressure, lb. per sq. in. abs.	115	65	65	38	18	18	15	115	65	65	38	18
Density, in lb. per cu. ft.	36.1	37.6	37.6	38.7	40.1	40.1	40.4	36.1	37.6	37.6	38.7	40.1
Approximate tons steel per ton of capacity	0.245	0.133	0.133	0.087	0.062	0.110	0.105	0.405	0.216	0.216	0.177	0.166
Approximate total tons of steel	73.5	39.9	39.9	26.1	18.6	33.0	31.05	121.5	64.8	64.8	53.1	49.8
Thickness of insulation, in.	0	0	0	2	4	12	12	0	0	0	2	4
Required refrigeration capacity, tons per 24 hr.	0	1.71	.....	1.03	1.25	0.50	0.56	0	4.13	.....	2.48	3.01
Average refrigeration load, tons per 24 hr.	0	.....	.....	0.02	0.42	0.17	0.22	0	.....	.....	0.05	1.00
Initial costs of:												
a. Containers, accessories, foundations	$28650	$19650	$19650	$15440	$15120	$12900	$12800	$44300	$26400	$26400	$21750	$20400
b. Insulation	0	0	0	1134	2234	1200	1200	0	0	0	2730	5376
c. Refrigeration plant	0	1420	0	1020	1160	620	670	0	2560	0	1820	2080
d. Water cooling system	0	0	600	0	0	0	0	0	0	1800	0	0
Total initial cost of storage plant	$28650	$21070	$20250	$17594	$18514	$14720	$14670	$44300	$28960	$28200	$26300	$27856
Total initial cost per ton of capacity	$ 95	$ 70	$ 68	$ 59	$ 62	$ 49	$ 49	$ 148	$ 96	$ 94	$ 88	$ 93
Annual operating costs:												
a. Investment charges												
(1) Containers, accessories, foundations	$ 2012	$ 1380	$ 1380	$ 1085	$ 1062	$ 906	$ 899	$ 3110	$ 1854	$ 1854	$ 1528	$ 1432
(2) Insulation	0	0	0	140	276	80	80	0	0	0	337	664
(3) Refrigeration plant	0	100	0	72	82	44	47	0	180	0	128	146
(4) Water cooling system	0	0	42	0	0	0	0	0	0	126	0	0
b. Taxes on complete plant	1146	843	810	704	741	589	587	1772	1158	1128	1052	1114
c. Maintenance, repair, supplies, misc.	1433	1054	1013	880	926	736	734	2215	1448	1410	1315	1393
d. Power, light, fuel	50	50	50	54	134	84	94	50	50	50	60	210
Total annual operating cost	$ 4641	$ 3427	$ 3295	$ 2935	$ 3221	$ 2439	$ 2441	$ 7147	$ 4690	$ 4568	$ 4420	$ 4959
Total annual operating cost per ton of capacity	$15.47	$11.42	$10.98	$ 9.78	$10.74	$ 8.13	$ 8.14	$23.82	$15.63	$15.23	$14.73	$16.53
Cost ratios for 300-ton capacity containers	1.90	1.41	1.35	1.20	1.32	1.00	1.00	2.93	1.92	1.87	1.81	2.04

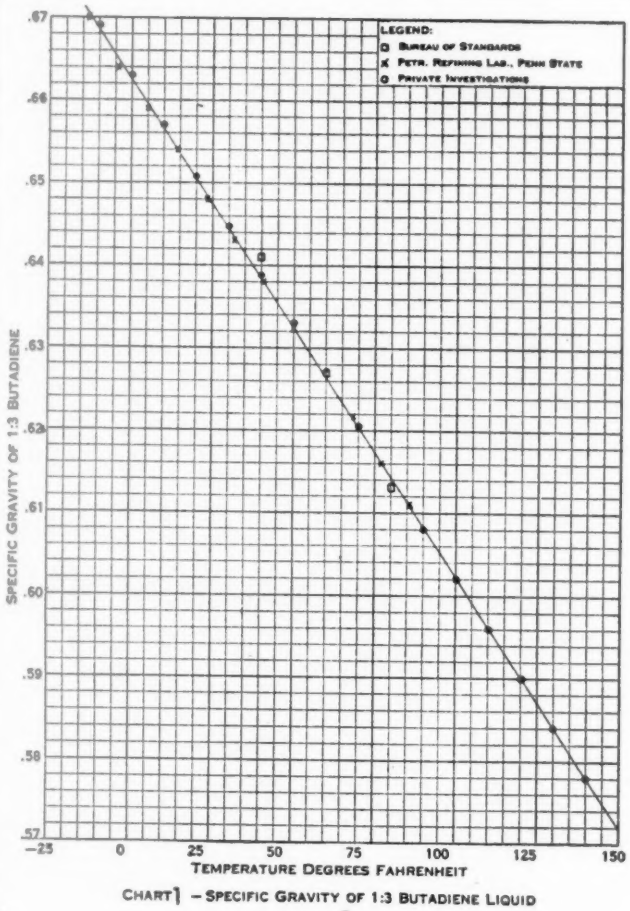


CHART 1 – SPECIFIC GRAVITY OF 1:3 BUTADIENE LIQUID

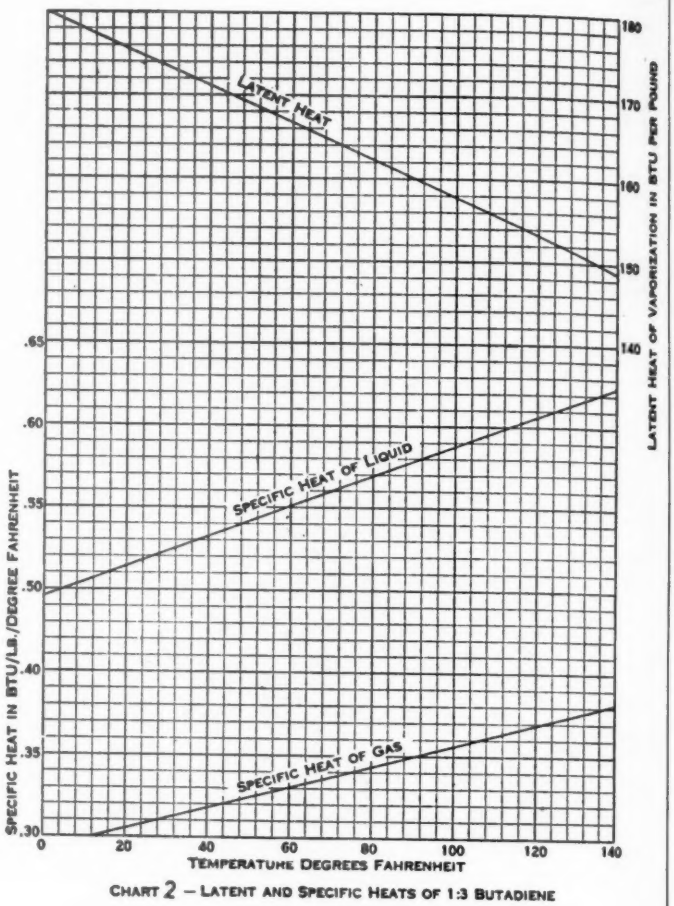


CHART 2 – LATENT AND SPECIFIC HEATS OF 1:3 BUTADIENE

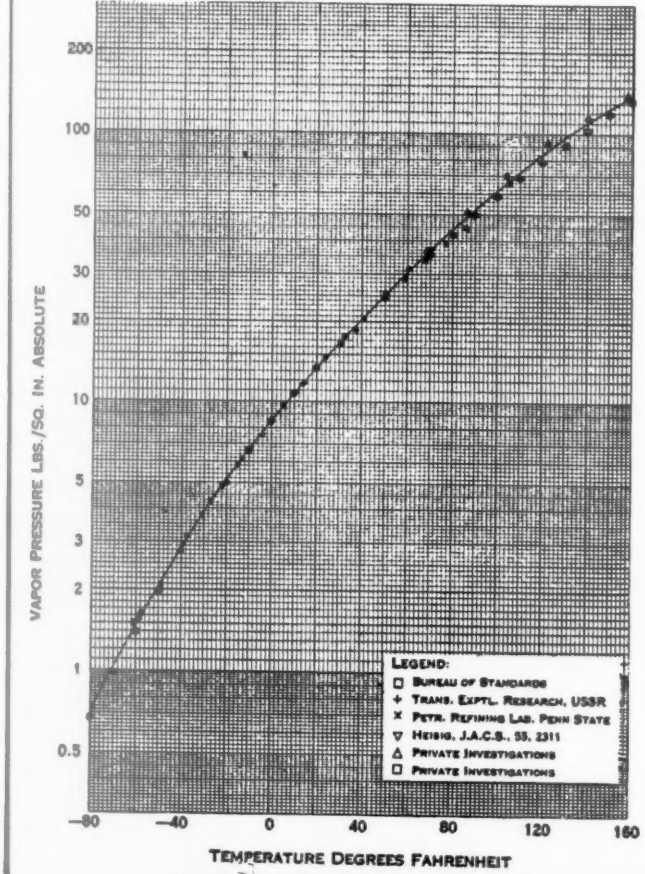


CHART 3 – VAPOR PRESSURES OF BUTADIENE

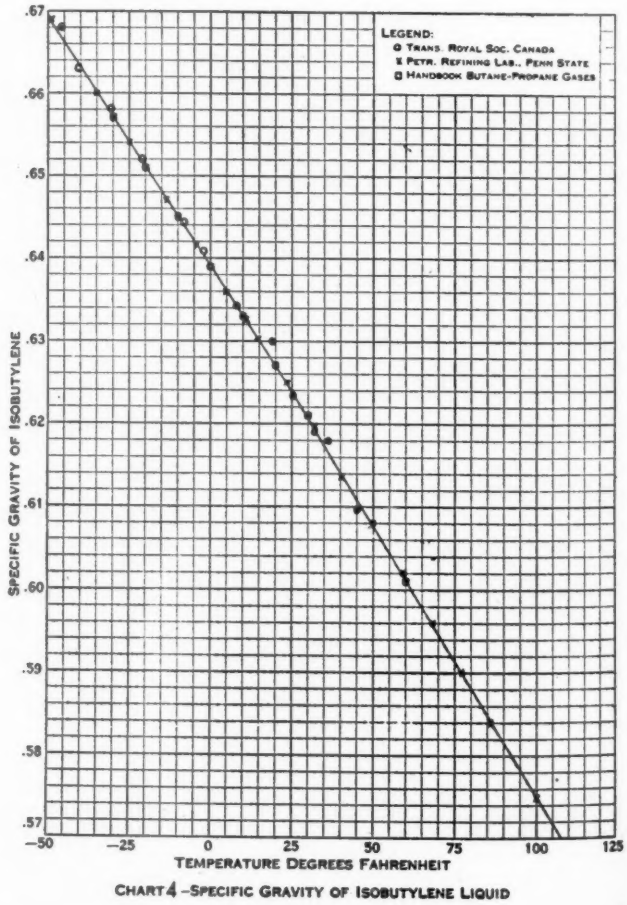


CHART 4 – SPECIFIC GRAVITY OF ISOBUTYLENE LIQUID

polymerization. Dimerization is apparently not catalyzed by oxidizing reagents, or by the type of surface. Polymerization, however, is catalyzed by active oxygen whether it is in the form of air, molecular oxygen, ozone, ozonides, or peroxides—organic or inorganic.[8] The mechanism of polymerization of ethylene compounds in general had been generally explained by Ostromyslenski in 1915.[9] Numerous investigators have studied the effect of various inhibitors upon the formation of polymers of butadiene.

Dimerization, on the other hand, seems to be unaffected by any known inhibitor. Various rates of polymerization are to be found in the literature. Several factors affecting rates of polymerization are: Temperature, light, contact with various metals and metallic alloys, water, and the purity of the butadiene studied. Small quantities of impurities have been known to exert noteworthy effect. The rate of polymerization due to increase of temperature is economically important and justifies the maintenance of the storage of butadiene in containers at a low and economically determined temperature. Increase of surface has not been found to affect the rate under any given set of conditions. Dimerization results when two molecules of butadiene unite to form a ring-type compound called "3-vinylcyclohexene." B. P. 129.5-130.5°C. (265.3-266.9°F.) at 760 mm. (14.7 lb. per sq. in.). High molecular weight polymerization results in the union of many molecules of butadiene to form long open chain compounds of negligibly low vapor pressures.

The following are catalyzers, inhibitors, and modifying agents:

1. Catalyzers: Air, tin, lead, stannic chloride, metallic sodium and other alkali metals, alkaline earth metals, amalgams or alloys of these metals, colloidal platinum or mercury or silver or manganese dioxide, metallo-organo compounds, boron trifluoride, barium peroxide, hydrogen peroxide, sodium perborate, ammonium persulphate, organic peroxides, organic peracids, sulphur, starch, oleates of sodium, ammonium, and cobalt, sodium stearate, albumen, casein, urea, soap, saponine, glycerine, and dioxan.

2. Inhibitors: Tertiary butyl catechol, hydroquinone, tricresol, phenyl-β-naphthylamine, diarylamines, and 1, 8 diaminonaphthalene.

3. Modifying agents: Carbon tetrachloride, hexachlorethane, terchlorpropionitrile, sodium cyanide, mercaptans. xanthogendisulphide, tiuram disulphides, and sulphinic acids.

The butadiene that was used in our study of polymerization reactions consisted of 98.7 per cent 1:3 butadiene, 0.27 per cent acetylenes, 1.173 per cent mixed butenes, and 0.10 per cent tertiary butyl catechol. The temperatures employed were 32°F., 80°F., and 92°F. This material was stored in a large mild steel container at a temperature of 32°F for a period of 612 days. The amount of total dimer and polymer was 0.45 per cent by weight or at the rate of 3.06×10^{-5}. (See Chart 6.) Pyrex sealed tubes were exposed to sunlight and/or infrared over a period of time and the entire content of the monomer was converted into a white crystalline solid polymer with an increase in volume of 2.5 to 3. Samples were sealed in pyrex glass tubes and heated gradually in an oil bath over a period of 8 hours up to and slightly above the critical temperature of the butadiene. The monomer was converted into a mixture of the dimer (identified by its boiling point and refractive index), a solid crystallized polymer, and a glassy transparent substance analgous in appearance to polystyron. Production, transportation, and storage conditions in the synthetic rubber industry have been very materially affected by the tendency of butadiene to polymerize. Fractionating columns and pipe lines have become clogged with both the crystalline and the crystallized solid polymers. Shipping containers such as cylinders and tank cars as well as storage containers now in use have been found to contain greater or less quantities of these polymers. The occurrence of polymers has

CHART 5—VAPOR PRESSURES OF ISOBUTYLENE

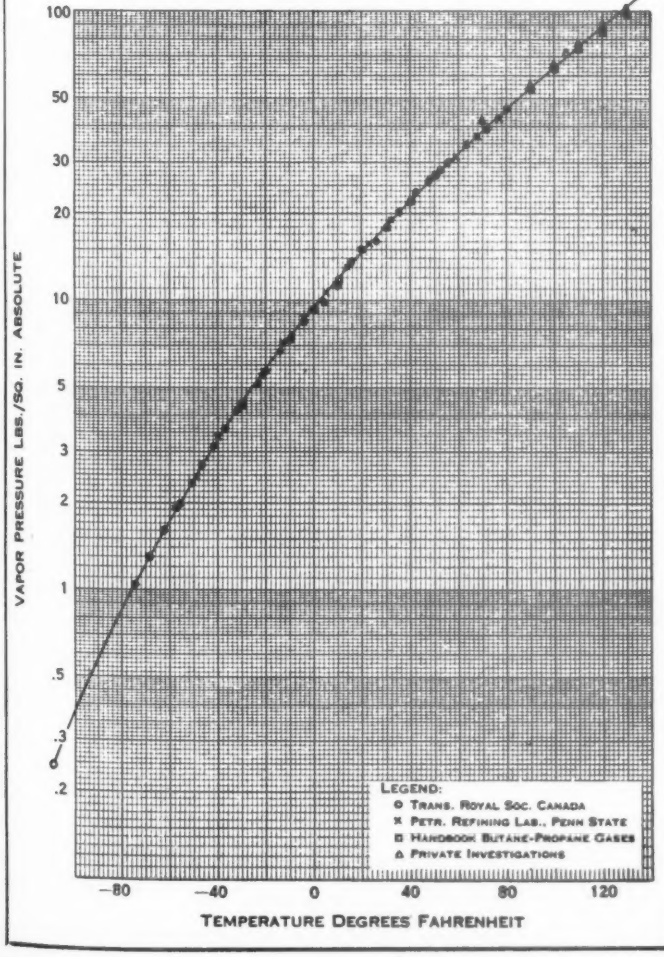
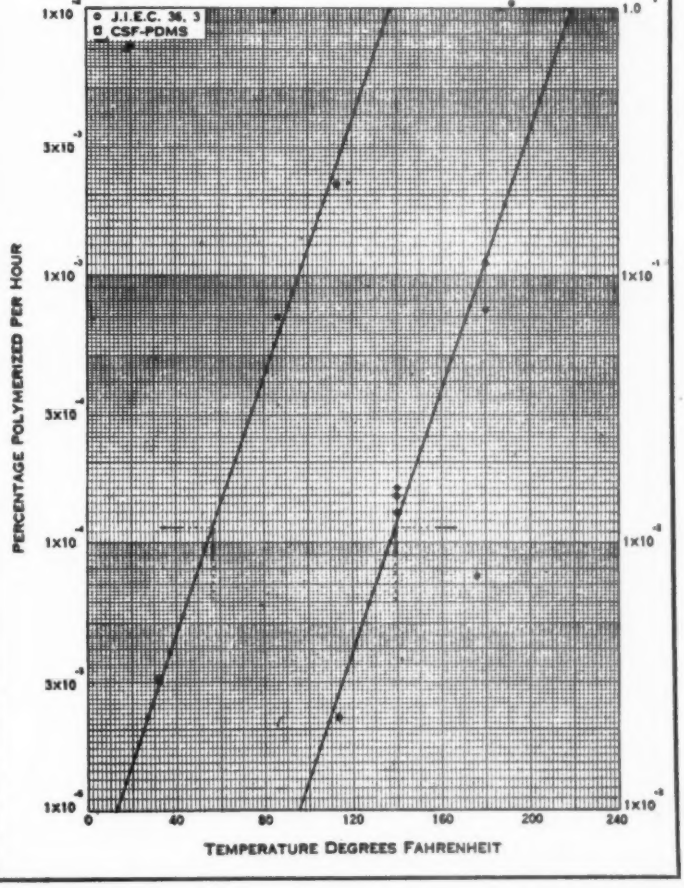


CHART 6—RATE OF POLYMERIZATION OF LIQUID BUTADIENE



necessitated interruptions in production, increased expenses in production, shipping, and storage. Noteworthy loss of valuable material has resulted.

Studies have been made of the effect of mill scale, metals, metallic alloys, liquid water, ordinary light, ultra violet light, and non-metallic coatings under different conditions of temperature. We have found that mill scale *per se* has no polymeric effect. The metallic substances that showed the least polymeric effect were mild steel, Tobin bronze, yellow brass, monel, stainless steel, and inconel. The polymeric effect of lead and tin were greatest. Nickel, cast iron, magnesium, zinc, aluminum, and copper showed intermediate polymeric action. Liquid water had the polymeric action of the metals and metallic alloys included in the intermediate class as given. Ordinary light at an average temperature of 86°F. had a greater polymeric effect than all the metals and metallic alloys studied except tin. Ultra violet light—2735 Angstrom units—at an average temperature of 90.5°F. had a greater polymeric action than any metal or metallic alloy. Fifteen commercially produced and used protective coatings have been studied. A majority of the coatings were applied to strips of mild steel in accordance with the instructions of the producers. Other coated strips were supplied by the producers. The coated strips of steel partially immersed in liquid butadiene in the absence of air and water were stored for various periods of time at an average temperature of 80°F. The time period was limited only by the results that were obtained. Some coatings have failed in one day, whereas two others have persisted for more than 90 days without any noticeable effect. For obvious reasons the trade names and the names of the producers are not given. A study has also been made of gasketing and packing materials.

Butadiene when processed under proper conditions with styrene yields the so-called buna-S rubbers, whereas when it is processed with acrylonitrile the Buna-N rubbers result and with isobutylene the so-called butyl rubbers are produced.

Isobutylene. Isobutylene is a very reactive hydrocarbon and it has been the subject of extended research covering the period 1825 to 1941. Isobutylene is an important industrial chemical in the production of such synthetic materials as alkylates, polygasolines, resins, and synthetic rubber. Isobutylene does not oxidize in the air to yield peroxides such as is the case with butadiene. In the presence of certain acid and silicate catalyzers isobutylene is converted into polymers containing from 2 to 7 and even more isobutylene units. A catalyst-like aluminum chloride produces polymers with varying high molecular weights. It has been found that by controlling the temperature polymers vary ing in molecular weight from di- and tri-polymers to as high as 300,000 molecular weight can be prepared. The physical properties of the various polymers range from viscous oily liquids to rubbery materials and finally to white tough elastic solids.[10] Generally speaking the polymers of isobutylene are linear and hence do not contain olefin groupings. These polymers have not been vulcanized;[11] however, they have fine electrical properties and maintain these properties within the temperature range of minus 58°F. to 212°F. Recently an 80-lb. capacity cylinder of isobutylene of the composition 98 per cent isobutylene, 1 per cent propane, and 1 per cent heavy residue was stored for a period of 8 months at room temperature of approximately 79°F. The material contained no inhibitor and air had not been replaced in the cylinder prior to the filling of it. Analysis by the micro-Podbielniak apparatus showed only 1 per cent polymer. Isobutylene, though a very reactive substance chemically, does not show any noteworthy tendencies to polymerize such as those described above with butadiene. Of especial interest at this time are the following: (1) The addition of isobutane to isobutylene to produce the high octane gasolines; (2) the polymeric changes of isobutylene in the presence of various catalysts, and (3) the polymerization of isobutylene and butadiene to produce the butyl rubbers.

Isobutylene does not corrode mild steel and hence can be stored in clean mild steel containers in the liquid phase at 32°F. for almost an indefinite period. Isobutylene has been found under these conditions to undergo a lowering of the pressure of the saturated vapor to the extent of 0.6 per cent.[12]

Considerations of storage. Storage requirements for butadiene and isobutylene are quite similar. The differences that exist are mainly conditioned upon their variations in densities and vapor pressures at any given temperature and their tendencies to polymerize. Neither substance is corrosive to mild steel at ambient temperatures. In mild steel containers, the thermal effect, resulting in polymerization, is much greater with butadiene than with isobutylene.

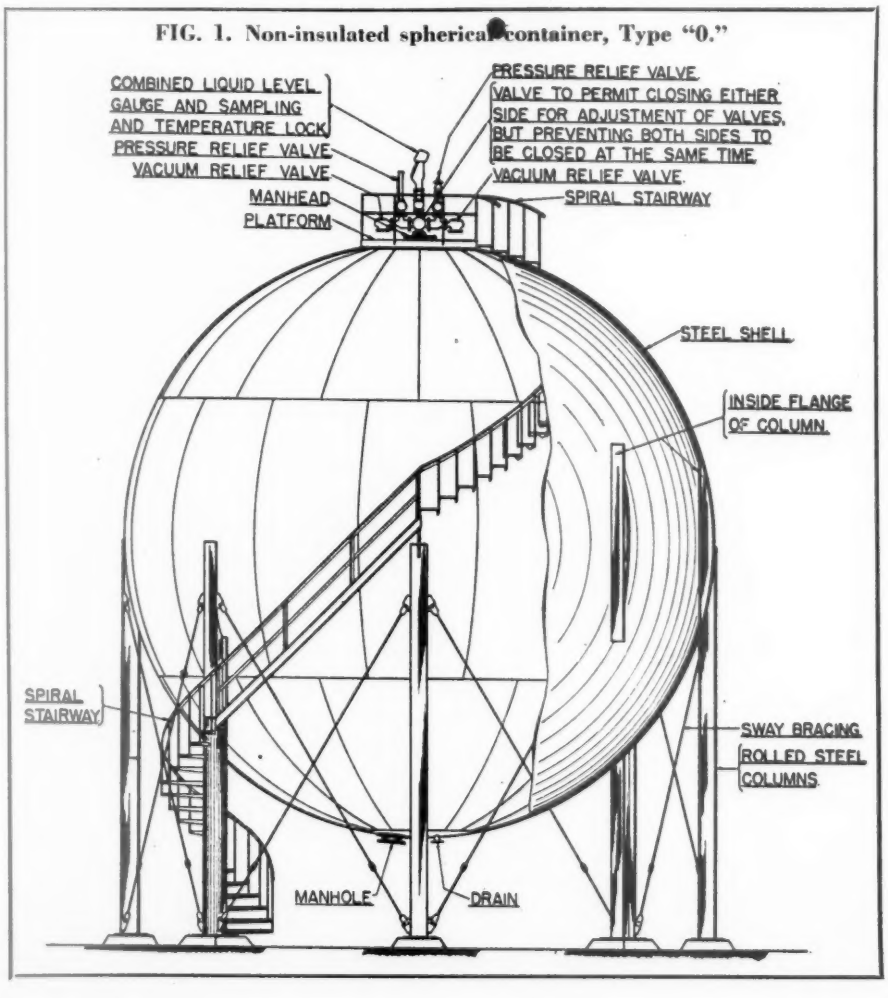
The solution to the problem of economical storage involves consideration of several variables, of which the more important are storage temperature, working pressure, and the type and capacity of the containers. Of these variables, temperature, the most important, defines: (a) working pressure and hence quantity and quality of steel required for construction; (b) refrigeration load and hence thickness and type of insulation due to changes of density, specific heat, etc., and (c) extent and rate of polymerization.

Types of containers. Nine types of stor-

Helium storage

Plans for storing helium underground on the 50,000-acre government-owned Cliffside natural gas field near Amarillo have been disclosed by Secretary Ickes. The gas will be injected into one of the 11 producing wells.

FIG. 1. Non-insulated spherical container, Type "0."


COMBINED LIQUID LEVEL GAUGE AND SAMPLING AND TEMPERATURE LOCK
PRESSURE RELIEF VALVE
VACUUM RELIEF VALVE
MANHEAD PLATFORM
PRESSURE RELIEF VALVE
VALVE TO PERMIT CLOSING EITHER SIDE FOR ADJUSTMENT OF VALVES, BUT PREVENTING BOTH SIDES TO BE CLOSED AT THE SAME TIME
VACUUM RELIEF VALVE
SPIRAL STAIRWAY
STEEL SHELL
INSIDE FLANGE OF COLUMN
SPIRAL STAIRWAY
SWAY BRACING
ROLLED STEEL COLUMNS
MANHOLE
DRAIN

age vessels have been studied for both raw materials. These are designated by the following numerals and letters:

"O" an uninsulated and unrefrigerated spherical vessel used to store gases and volatile liquids under pressure.

"OR" an uninsulated but refrigerated container otherwise identical with type "O." The refrigeration unit is mounted on top of the container.

"OW" an uninsulated but water cooled spherical container.

"10" an insulated and refrigerated spherical container.

"45" an insulated and refrigerated double-walled cylindrical vessel designed especially for the storage of volatile liquids at working pressures under 10 lb. per sq. in.

"100" an insulated and unrefrigerated horizontal cylindrical container 10 ft. in diam. by 50 ft. long.

"100-R" uninsulated but refrigerated vessel otherwise identical with type "100."

"100-W" an uninsulated but water-cooled vessel otherwise identical with type "100."

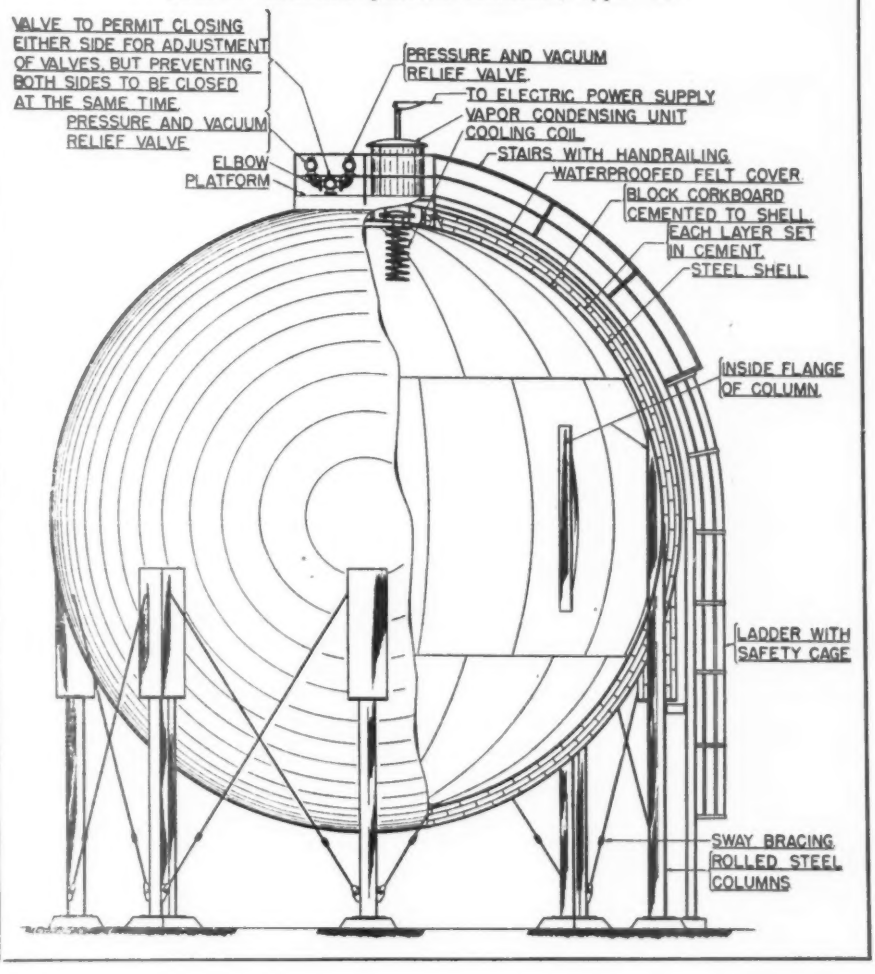
"110" insulated and refrigerated vessel otherwise identical with type "100."

Capacities studied range from 100 to 700 tons. The amount of steel required for any container is of vital concern and increases with increase in storage pressure. Vessels of types "100" and "110" require about twice as much steel as type "O" for any given storage capacity or working pressure. Type "O" requires less steel than type "45" because type "45" is designed as a double-walled vessel but the double-walled construction permits the use of more economical insulating materials; thus, effecting a saving in the cost of such an installation.

Insulation. The thickness of insulation is computed from the following equation:

$$t = \sqrt{\frac{CkRT}{I}}$$

FIG. 2. Insulated spherical container, Type "10."


VALVE TO PERMIT CLOSING EITHER SIDE FOR ADJUSTMENT OF VALVES, BUT PREVENTING BOTH SIDES TO BE CLOSED AT THE SAME TIME.
PRESSURE AND VACUUM RELIEF VALVE
ELBOW
PLATFORM
PRESSURE AND VACUUM RELIEF VALVE.
TO ELECTRIC POWER SUPPLY
VAPOR CONDENSING UNIT
COOLING COIL
STAIRS WITH HANDRAILING
WATERPROOFED FELT COVER
BLOCK CORKBOARD CEMENTED TO SHELL, EACH LAYER SET IN CEMENT.
STEEL SHELL
INSIDE FLANGE OF COLUMN
LADDER WITH SAFETY CAGE
SWAY BRACING
ROLLED STEEL COLUMNS

Where:

"t" = economical thickness, in.,

"R" = cost of refrigeration in dollars per ton day,

"I" = cost of insulation in dollars per cu. ft. installed,

"T" = average temperature differential, °F.,

"k" = thermal conductivity in B.t.u. per sq. ft. per hr. per in. per °F., and,

"C" = a value that varies with the type of insulation.

TABLE 2

Cost comparisons for 700-ton storage capacity

Type of container	"0"	"OR"	"OW"	"10"	"10"	"45"	"45"	"100"	"100R"	"100W"	"110"	"110"
Storage temperature, °F	140	100	100	70	32	32	24	140	100	100	70	32
Working pressure, lb. per sq. in. gage	100	50	50	23	3	3	0	100	50	50	23	3
Vapor pressure, lb. per sq. in. abs.	115	65	65	38	18	18	15	115	65	65	38	18
Density, lb. per cu. ft.	36.1	37.6	37.6	38.7	40.1	40.1	40.4	36.1	37.6	37.6	38.7	40.1
Approximate tons steel per ton of capacity	0.245	0.133	0.133	0.087	0.062	0.110	0.105	0.405	0.216	0.216	0.177	0.166
Approximate total tons of steel	171.5	93.1	93.1	60.9	43.4	77.0	73.5	283.5	151.2	151.2	123.9	116.2
Thickness of insulation, in.	0	0	0	2	4	12	12	0	0	0	2	4
Required refrigeration capacity, tons per 24 hr.	0	3.01	.....	1.81	2.20	0.87	0.98	0	9.63	.....	5.80	7.01
Average refrigeration load, tons per 24 hr.	0	.....	.....	0.03	0.73	0.29	0.39	0	.....	.....	0.11	2.33
Initial costs of:												
a. Containers, accessories, foundations	$55600	$38400	$38400	$29400	$27300	$22100	$21900	$99400	$59000	$59000	$48700	$45500
b. Insulation	0	0	0	1994	3920	2100	2100	0	0	0	6366	12534
c. Refrigeration plant	0	2080	0	1470	1680	900	980	0	4520	0	3210	3640
d. Water cooling system	0	0	800	0	0	0	0	0	0	[3700	0	0
Total initial cost of storage plant	$55600	$40480	$39200	$32964	$32900	$25100	$24980	$99400	$63520	$62700	$58276	$61674
Total initial cost per ton of capacity	$ 79	$ 58	$ 56	$ 47	$ 47	$ 36	$ 36	$ 142	$ 91	$ 90	$ 83	$ 88
Annual operating costs:												
a. Investment charges												
(1) Containers, accessories, foundations	$ 3905	$ 2695	$ 2695	$ 2065	$ 1918	$ 1552	$ 1538	$ 6980	$ 4140	$ 4140	$ 3420	$ 3195
(2) Insulation	0	0	0	246	484	140	140	0	0	0	786	1548
(3) Refrigeration plant	0	146	0	103	118	63	69	0	318	0	226	256
(4) Water cooling system	0	0	56	0	0	0	0	0	0	259	0	0
b. Taxes on complete plant	2224	1619	1568	1319	1316	1004	999	3976	2541	2508	2331	2467
c. Maintenance, repair, supplies, misc.	2780	2024	1960	1648	1645	1255	1249	4970	3176	3135	2914	3084
d. Power, light, fuel	50	50	50	56	178	108	128	50	50	50	72	400
Total annual operating cost	$ 8959	$ 6534	$ 6329	$ 5437	$ 5659	$ 4122	$ 4123	$15976	$10225	$10092	$ 9749	$10950
Total annual operating cost per ton of capacity	$12.80	$ 9.33	$ 9.04	$ 7.77	$ 8.08	$ 5.89	$ 5.89	$22.82	$14.61	$14.42	$13.93	$15.64
Cost ratios for 700-ton capacity containers	2.17	1.58	1.53	1.32	1.37	1.00	1.00	3.87	2.48	2.45	2.36	2.65

TABLE 3

Heat transmission and insulation data—butadiene

Storage capacity, tons	Tank type, number	Storage temp., °F.	Average diff., °F.	Thickness of insulation, in.	B.t.u. per sq. ft. per °F. per hr.	Approx. surface area, sq. ft.	Average cooling load, B.t.u. per hr.	Average refr. load, tons per 24 hr.	Max. cooling load, B.t.u. per hr.	Max. refr. load, tons per 24 hr.	Approx. cu. ft. insulation required
300	"0"	140	....	..	6.00	3530	.....	....	.....	.....	....
	"OR"	100	....	..	6.00	3420	.....	....	20520	1.71	....
	"10"	70	0.5	2	0.14	3400	238	0.02	12380	1.03	567
	"10"	32	21.3	4	0.07	3350	5000	0.42	15010	1.25	1117
	"45"	32	21.3	12	0.023	4000	1988	0.17	5970	0.50	5000
	"45"	24	28.5	12	0.023	4000	2660	0.22	6710	0.56	4000
	"100"	140	....	..	6.00	8600	.....	....	.....	.....	....
	"100R"	100	....	..	6.00	8260	.....	....	49560	4.13	....
	"110"	70	0.5	2	0.14	8190	573	0.05	29800	2.48	1365
	"110"	32	21.3	4	0.07	8065	12020	1.00	36150	3.01	2688
700	"0"	140	....	..	6.00	6180	.....	....	.....	.....	....
	"OR"	100	....	..	6.00	6020	.....	....	36120	3.01	....
	"10"	70	0.5	2	0.14	5980	419	0.03	21750	1.81	997
	"10"	32	21.3	4	0.07	5880	8760	0.73	26350	2.20	1960
	"45"	32	21.3	12	0.023	7000	3470	0.29	10420	0.87	7000
	"45"	24	28.5	12	0.023	7000	4640	0.39	11720	0.98	7000
	"100"	140	....	..	6.00	20080	.....	....	.....	.....	....
	"100R"	100	....	..	6.00	19270	.....	....	115620	9.63	....
	"110"	70	0.5	2	0.14	19100	1338	0.11	69600	5.80	3183
	"110"	32	21.3	4	0.07	18800	28000	2.33	84100	7.01	6267

Corkboard or similar material is used for the single shell containers, type "10" and "110," and rock wool or similar material is used for the double shell container type "45." The unit cost of insulation in place depends upon the type and quantity required. The cost of refrigeration per ton depends upon the initial and operating costs of the refrigeration plant. The average temperature differential depends upon the storage temperature and upon the monthly mean temperature at the site of the storage plant. The thermal conductivity will vary with the type of material, its density, and the temperature level. The term "C" is a combined value that includes the investment factor and other factors relative to the derivation of the equation.

Thus for type "10" or "110," 32°F. storage in the Pittsburgh district, using corkboard, we have:

$$t = \sqrt{\frac{1.70 \times 0.28 \times 2.50 \times 21.3}{2.00}}$$

$= 3.6$ in.—use 4 in.

For type "45," 32°F. storage in Pittsburgh district, using rock wool, we have:

$$t = \sqrt{\frac{2.66 \times 0.28 \times 2.50 \times 21.3}{0.30}}$$

$= 11.5$ in. — use 12 in.

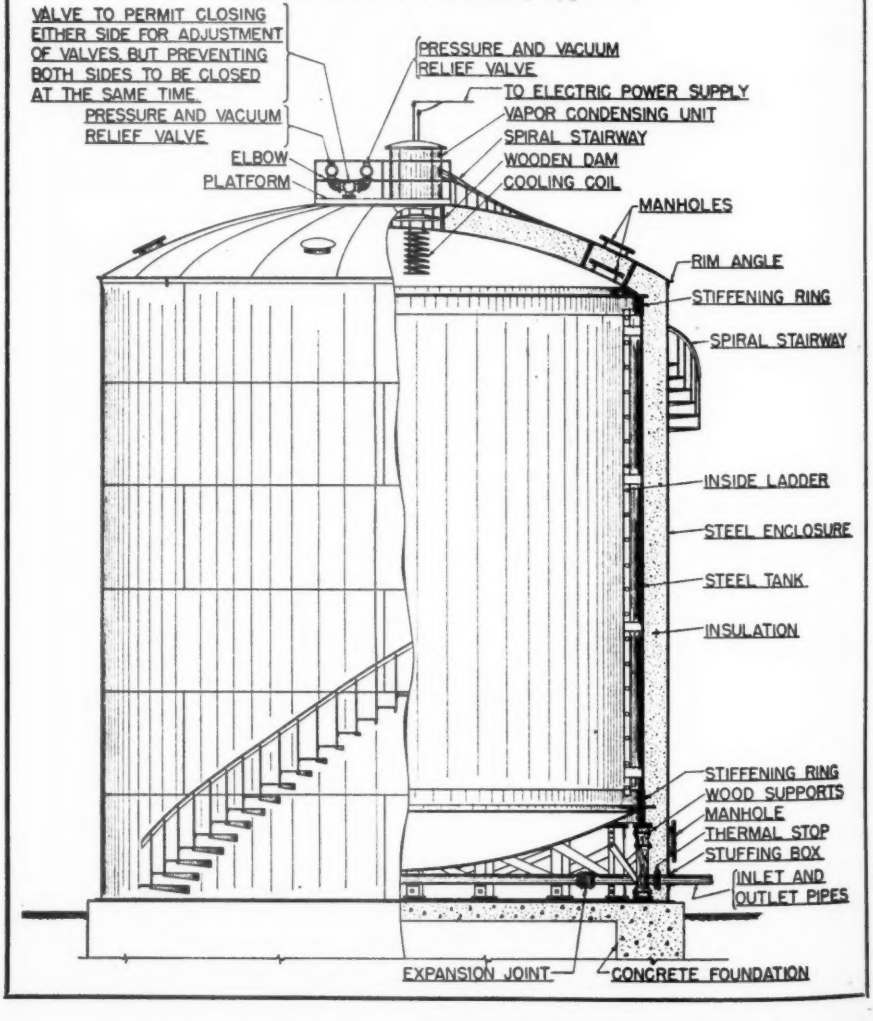
The thickness of insulation determines the capacity and average cooling load of the refrigeration plant, for it governs the heat transmission into the container.

The amount of heat transmitted depends upon the kind, density, and thickness of insulation, the exposed area and the vessel's shape factor, as well as the temperature differences between the inside of the vessel and the atmosphere. The thermal conductivity varies with the kind and density of material and the temperature level at which the material is used.

Costs. The initial costs of the containers, accessories, foundations, insulation, and refrigeration, or water cooling plant, are based upon current estimating units for materials and labor. The cost of each storage plant is made up of different proportions of material, fabrication, freight, and erection costs. The annual operating costs consist of investment charges, taxes, maintenance and repair, supplies and miscellaneous, power, light, and fuel.

The investment charges for the containers, accessories, and foundations are based upon a 20-year life, 10 per cent salvage value, 4 per cent sinking fund interest, and 4 per cent bond interest, for a combined figure of 7.02236 per cent of the initial cost. The investment charges for corkboard, used on the single-walled containers, are based upon a 10-year life, no salvage value, 4 per cent sinking fund interest, and 4 per cent bond interest, for a combined figure of 12.32909 per cent of the initial cost. The investment charges for rock wool, used for the double-wall containers, are based upon a 20-year life, 20 per cent salvage

FIG. 3. Insulated container, Type "45."



value, 4 per cent sinking fund interest, and 4 per cent bond interest, for a combined figure of 6.68654 per cent of the initial cost of the insulation. Similar sets of investment charges may be made wherein other insulating materials are used. The investment charges for the refrigeration or water cooling plant are based upon a 20-year life, 10 per cent salvage value, 4 per cent sinking fund interest, and 4 per cent bond interest, for a combined figure of 7.02236 per cent of the initial cost of the refrigeration plant.

Taxes have been computed at 4 per cent; maintenance and repairs vary from 4 to 10 per cent depending upon the type of plant and the load factor. In the cost tabulations 4 per cent has been used. Supplies and miscellaneous amount to 1 per cent of the initial cost. Power, light, and fuel costs have been based upon prevailing rates.

Cost comparisons for 300 and 700 ton storage capacities of several types of vessels. Tables 1 and 2 are typical of the several tabulations that have been made. The cost of storing either butadiene or isobutylene shows only slight differences and for general purposes of consideration the cost may be assumed to be identical.

Heat transmission. Insulation data for the various types of containers of 300 and 700 tons capacity are shown in Tables 3 and 4.

Recommendations for storage containers. *Temperature and pressure.* 1:3 butadiene should be stored as a liquid at as low a temperature as is economically feasible. When precooling is unnecessary, the most economical temperature is about 32°F., with a corresponding working pressure of 3 lb. per sq. in. gage in the case of butadiene and 4 lb. per sq. in. gage in the case of isobutylene.

Type of container. 1:3 butadiene and isobutylene should be stored in vapor-tight containers free of air and moisture. Type "45," an insulated and refrigerated cylindrical container with suspended bottom and dome roof, appears to be the most economical for the recommended temperature of about 32°F.

Container material. Low pressure containers (under 15 lb. per sq. in. gage) should be of welded construction using mild steel of ASTM specification A-10. Containers designed for pressures in excess of 15 lb. per sq. in. gage should also be of welded construction using flange or fire-box boiler grade steel of ASTM specification A-70 to comply with the API-ASME code for unfired pressure vessels. Mill scale should be removed by sand, grit, or shot blasting, or flame-descaling, or pickling. Stainless steel would be very satisfactory but the added cost is not considered justifiable.

The exterior of the storage vessels should preferably be painted with aluminum paint, whereas a protective coating should be used on the interior of the storage vessel to minimize corrosion from water vapor and any impurities that may be contained in these substances. The protective coating found most suitable is the phenol-formaldehyde type.

Accessories. Stainless steel, monel, mild steel, Tobin bronze, or yellow brass may be used for miscellaneous valves and fittings.

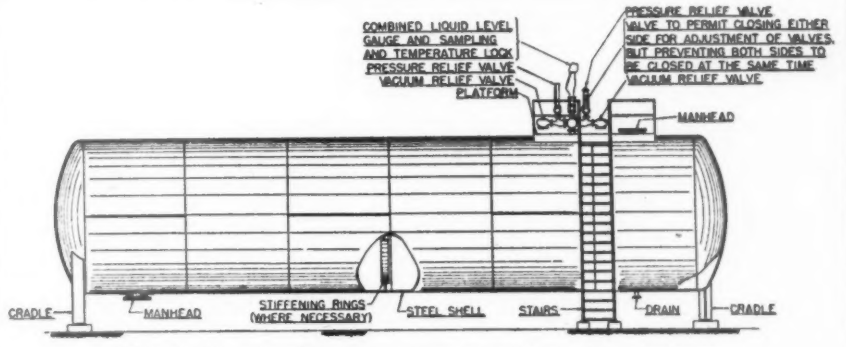


FIG. 4. Non-insulated horizontal container, Type "100."

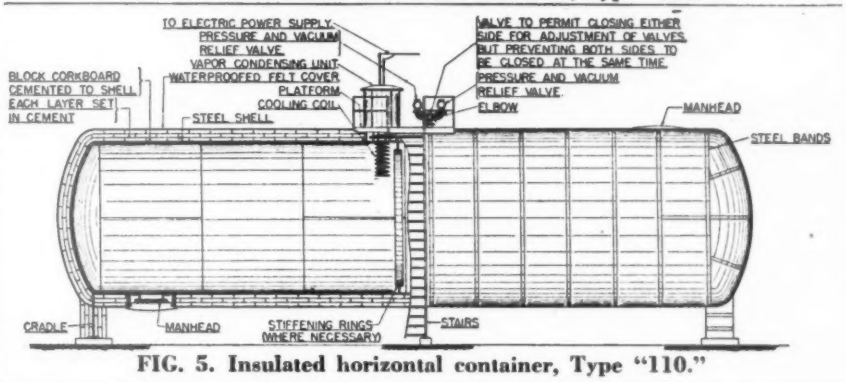


FIG. 5. Insulated horizontal container, Type "110."

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1. ***Petroleum Refiner*, Vol. 21, No. 10, p. 162.**
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4. ***Handbook Propane-Butane Gases*, 3rd edition.**
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12. ***Ind. and Eng. Chem.* 32, p. 293.**

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TABLE 4

Heat transmission and insulation data—isobutylene

Storage capacity, tons	Tank type, number	Storage temp., °F.	Average diff., °F.	Thickness of insulation, in.	B.t.u. per sq. ft. per °F. per hr.	Approx. surface area, sq. ft.	Average cooling load, B.t.u. per hr.	Average refr. load, tons per 24 hr.	Max. cooling load, B.t.u. per hr.	Max. refr. load, tons per 24 hr.	Approx. cu. ft. insulation required
300	"0"	140	....	..	6.00	3620	.....	....	.....	....	....
	"OR"	100	....	..	6.00	3500	.....	....	21000	1.75	....
	"10"	70	0.5	2	0.14	3480	244	0.02	12670	1.05	580
	"10"	32	21.3	4	0.07	3430	5090	0.42	15380	1.29	1143
	"45"	32	21.3	12	0.023	4100	2000	0.17	6030	0.50	4100
	"45"	20	32.5	12	0.023	4050	3020	0.25	7080	0.59	4050
	"100"	140	....	..	6.00	8810	.....	....	.....	....	....
	"100R"	100	....	..	6.00	8460	.....	....	50760	4.23	....
	"110"	70	0.5	2	0.14	8390	587	0.05	30520	2.54	1398
	"110"	32	21.3	4	0.07	8260	12270	1.02	37000	3.08	2753
700	"0"	140	....	..	6.00	6330	.....	....	.....	....	....
	"OR"	100	....	..	6.00	6160	.....	....	36960	3.08	....
	"10"	70	0.5	2	0.14	6120	429	0.04	22250	1.85	1020
	"10"	32	21.3	4	0.07	6020	8950	0.75	27000	2.25	2007
	"45"	32	21.3	12	0.023	7170	3500	0.29	10540	0.88	7170
	"45"	20	32.5	12	0.023	7090	5290	0.43	12400	1.03	7090
	"100"	140	....	..	6.00	20600	.....	....	.....	....	....
	"100R"	100	....	..	6.00	19740	.....	....	108440	9.04	....
	"110"	70	0.5	2	0.14	10580	1370	0.11	71200	5.93	3263
	"110"	32	21.3	4	0.07	19270	28600	2.38	86300	7.19	6423

Biggest single installation o

TYPE G·M ANGLE Compressors

New York Washington Bradford, Pa. Parkersburg, W. Va. San Francisco, Cal. Seattle, Wash. Hous

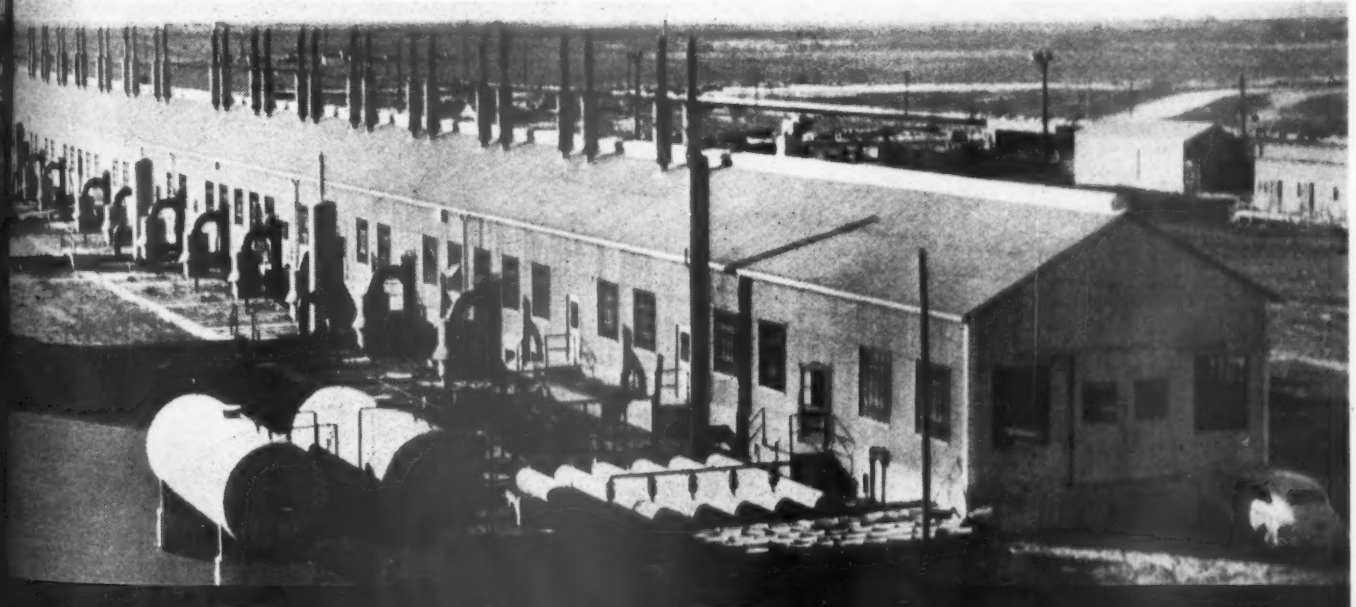
...on of Gas-line "Angles"...

15,000 G-MV HORSEPOWER

The photograph on the opposite page shows only eight of fifteen 10-cylinder, 1,000-hp. Cooper-Bessemer G-MV units installed in Cities Service Gas Company's new pipeline compressor station at Guymon, Oklahoma. All fifteen G-MV's are housed in the one building shown below, the biggest gas pipeline installation of "angle" compressors ever made.

Each G-MV drives three double-acting compressor cylinders with a rated capacity of 18,000,000 cubic feet per day. Thus 270,000,000 cubic feet of gas can now be delivered daily from the Hugoton Field to Blackwell, Oklahoma, into the Cities Service system.

Here is another outstanding installation adding to the mountain of evidence that the G-MV is recognized as a star performer, selected repeatedly for its overall efficiency, its modern compactness, and its reliable performance.



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MOUNT VERNON, OHIO AND GROVE CITY, PENNA.

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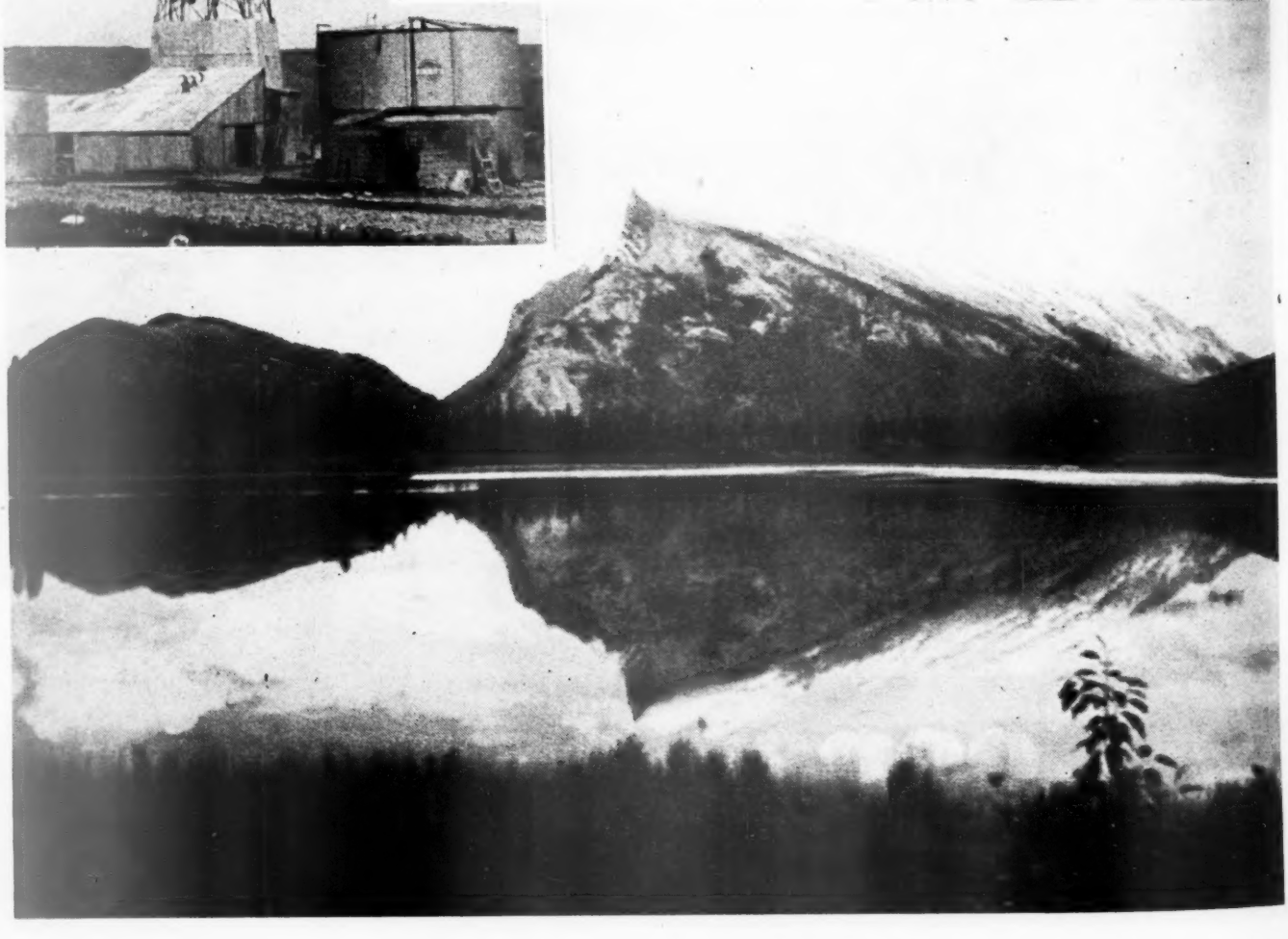
SHELL JUMPINGPOUND WELL DISCOVERS MAJOR FIELD

By **FLOYD K. BEACH,** *Engineer*
The Petroleum and Natural Gas Conservation Board, Alberta

EXCLUSIVE SHELL 4-24-J in the Jumpingpound area about 25 miles west of Calgary is considered by competent observers to mark the discovery of a new major oil field. It is quite true that one swallow doesn't make a summer, and a single well doesn't always make an oil field, but the indications obtained in this well are so good as to warrant considerable optimism. The discovery comes after three years of wildcatting by Shell Oil Company of Canada in Alberta and credit for finding oil in this spot goes jointly to the geologist, the geophysicist, and the drill. It seems a safe observation that no one of the three could alone have been successful. The drill alone might have found it, but only after quite a large number of unsuccessful and highly expensive tries.

In an accompanying photograph of Mount Rundle at Banff can be seen exposed a fault block of limestone of Mississippian age that has given its name to the producing horizon in Turner Valley, and the attitude of the beds is quite similar to the attitude of the producing horizon in Turner Valley. In fact, there is a consistent tendency in the Rocky Mountain ranges and in the buried fault blocks of the foothills disturbed belt, for the competent Palaeozoic rocks to show westerly dipping beds, successive fault blocks lying in echelon, one after another eastward from the front range to the easterly limit of the disturbed belt. When the limestone fault blocks are covered by a half mile to three or four miles in thickness of younger sediments, all of which have also been faulted and folded in the course of the Laramide revolution, surface traces of disturbance are exceedingly difficult for the geologist to interpret in terms of depth to the limestone. The geophysicist also has his troubles as anyone may imagine who begins to speculate on the manner in which seismic waves are likely to be reflected from the inclined surface of Mount Run-



Shell 4-24-J, Jumpingpound discovery well. Below is Mount Rundle at Banff. Upper beds of this snow-covered mountain are light colored limestone, the same kind of beds that form the producing oil horizon in Turner Valley and Jumpingpound. In Turner Valley the attitude of the beds is much the same as in this mountain. ***Photo at left by W. J. Mack; below by Mr. Beach.***

...and here is the Totco Recorder which is helping to keep the Jumpingpound wells in line.

The Shell Oil Company, drilling in the Jumpingpound field, wants those wells to go straight down—not sideways. That's why they regularly take deviation tests with the Totco Recorder, just as hundreds of other oil companies and leading drilling contractors have done, for over ten years, in nearly every oil field in the world.

If in the recent past a Totco has not been available exactly when you wanted it—here's good news. Part of our greatly expanded facilities, for 2 years entirely devoted to producing precision war instruments, are again making Totco Recorders and Go-devils. In a few weeks our supplies will be back to normal.

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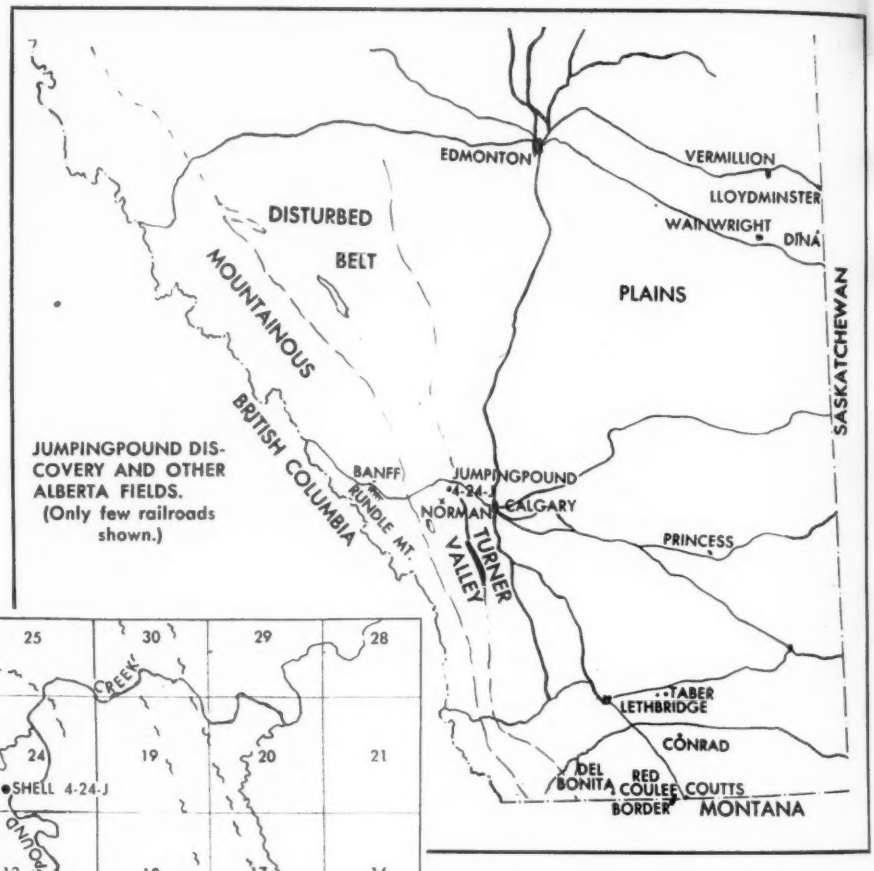
dle if it were so buried under younger sediments, especially when it is known that the younger sediments contain reflecting horizons that are not necessarily parallel to the limestone beds.

Turner Valley in 20 years has produced nearly 75,000,000 bbl. of oil and consequently rates as a major oil field. It is now developed for some 21 miles north and south and ½ to 2½ miles east and west. When one considers that the disturbed belt is 350 miles long in Alberta, not to mention the extension northward in British Columbia, and that it has a considerable breadth, there is room for much hope that other major fields may be found in it. This hope has led to a number of tests, all of them expensive, and the Jumpingpound discovery is the first successful test outside the known limits of Turner Valley.

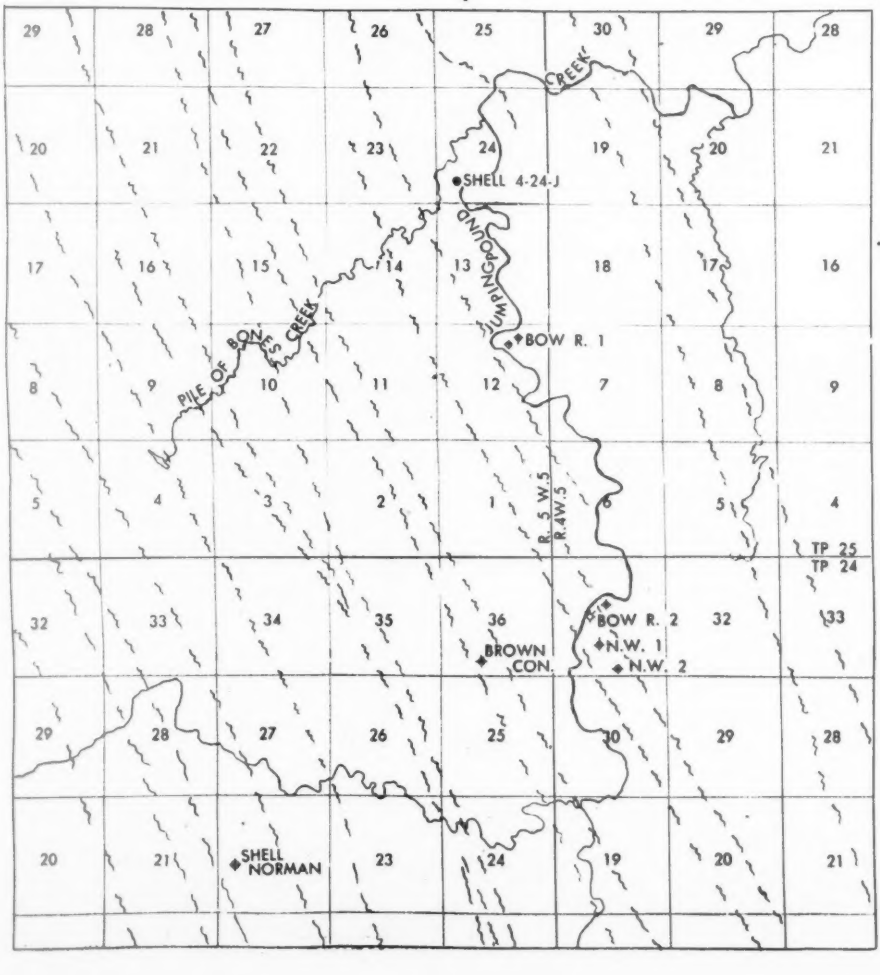
A number of earlier wells were drilled in the general area. Several wells as early as 1914 did not go deep enough to prove anything. One well drilled by Imperial Oil or one of its subsidiaries found gas in a sand some distance above the line and was left as a gas supply for the farmer on whose land the well is situated. Gas from this well has been used as fuel in drilling three subsequent wells. One well, drilled by Brown Consolidated, went to 6885 ft. only to find a fault after reaching a point not far stratigraphically above the lime. The age of beds below the fault indicated that continued drilling would be inadvisable. Northwest Company in its Bow River 2, situated to the east of the Brown well, had previously faulted at about the same stratigraphic horizon, although at shallower depth. Some geophysical work was done after the Brown well was drilled and Shell came into the picture after a seismic survey had been made. Shell Norman was drilled some 24 miles due west from the center of the city of Calgary, and about the same distance north from the north limit of Turner Valley. It found the Rundle lime at 11,585 ft. (7239 ft. subsea) and the lime had good porosity—much as in Turner Valley but containing salt water. It reached its final depth in October, 1943, after 15 months of drilling.

Further seismic surveys were made, and using the data obtained in the first test, with careful study by the company's geological department, Well 4-24-J was located 6 miles farther north and 2 miles east. Benefiting by the previous experience in drilling the disturbed Cretaceous and Jurassic beds above the lime, very good time was made in drilling, and 6 months saw the well at final depth. The top of the Rundle was found at 9618 ft. (5598 ft. subsea). The thickness of the Upper Rundle (light colored limestone and dolomite) was only 229 ft. or about half the thickness found in Turner Valley. On reaching the "dark lime," or lower Rundle, it was decided to drill farther in order to be certain that all porous horizons had been tested, and about 100 ft. of "dark lime" was penetrated, but without encouragement.



JUMPINGPOUND DISCOVERY AND OTHER ALBERTA FIELDS. (Only few railroads shown.)

Base map by Geological Survey
JUMPINGPOUND AREA



▶ **Tests.** After penetrating the first porous horizon, a drill stem test was made. When the tester was set with a ½-in. bottom-hole choke, the valve was opened and in 4 minutes gas reached the surface, and the flow was estimated at about 500,000 cu. ft. per day. No water was observed. After being open for 30 minutes the by-pass in the tester failed and drilling mud filled 6000 ft. of drill pipe. On reaching the "dark lime," a second drill-stem test was made with ⅜-in. choke. Again gas reached the surface in 4 min-

Baash-Ross News

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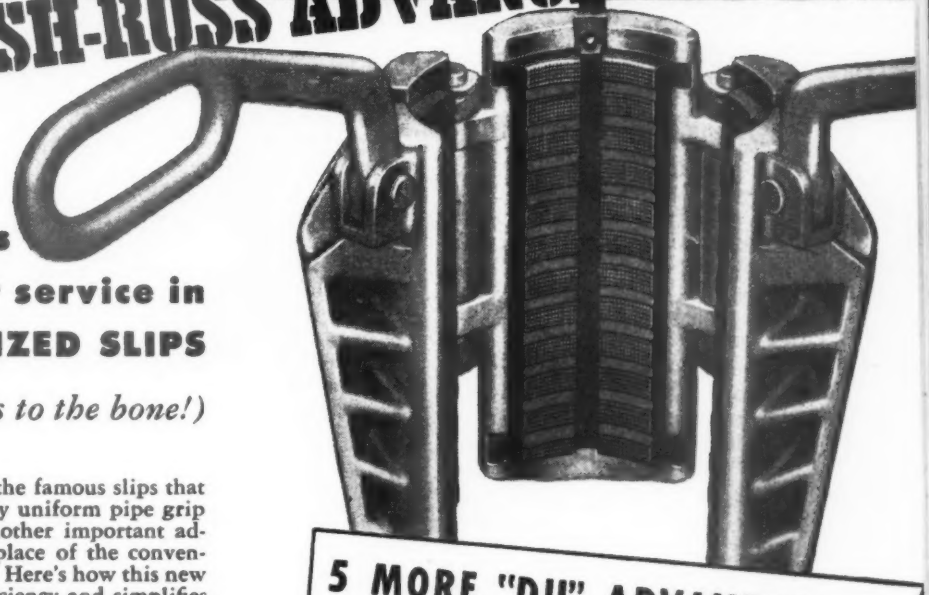
ANOTHER BAASH-ROSS ADVANCEMENT



How shortening the liners has lengthened their service in BAASH-ROSS "DU" UNITIZED SLIPS

(Also cuts inventory requirements to the bone!)

BAASH-ROSS "DU" ROTARY SLIPS—the famous slips that are *unitized* to assure an absolutely uniform pipe grip on every setting--now embody another important advancement—4" liner segments in place of the conventional 12" or 16" full-length liners. Here's how this new development saves you money, increases slip efficiency and simplifies inventory requirements—a 3-way saving . . .

SAME LINER UNIT FITS BOTH LONG AND SHORT BODIES

Whether you use 12" "DU" Slips or 16" "DU" Slips—or some of one and some of the other in your field operations, you need stock only *one* standard size of slip liner to fit both bodies. To reline a 12" body simply insert *three* 4" liner segments. To reline a 16" body use *four*. No need to maintain a complete stock of different length liners . . . an important advantage in any oilfield operations, but particularly in remote locations. Incidentally, the liner-retaining arrangement in "DU" Slips is so designed that the multiple short liners are held just as firmly as single longer liners.

LONGER LIFE FROM SLIP LINERS

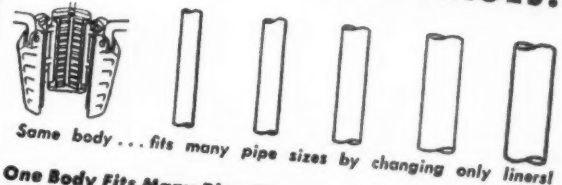
And here's a BIG feature of the new short liners . . . if the taper of your master bushing bore is worn—or if for some other reason liner wear is more concentrated on one part of the slip surface than on the rest—there's no need to throw away the entire liner because just one part is worn, as with conventional liners. Simply take out the short section that is worn—usually the bottom part—and change its position with one of the other sections that is not worn. Thus, in many cases you can renew the slip efficiency without replacing a single part—but just by rearranging liner positions in body.

And in still other cases, where one section becomes too worn for further use but the others are still good, you can simply replace that one part with a new one and continue to get additional service from the other sections.

These features all add up to easier maintenance of maximum slip efficiency . . . at substantially lower cost than with full-length liners—and with spare liner inventories kept at an absolute minimum!

With this new advantage it is more essential than ever that you investigate Baash-Ross "DU" Slips for *your* rig operations. They're available in standard length to fit all pipe sizes 2-3/8" to 7" . . . and in long length for pipe 2-3/8" to 5-9/16". Get the details from your Baash-Ross representative—see page 263 of your Composite Catalog—or write direct!

5 MORE "DU" ADVANTAGES!

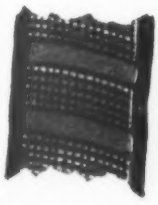


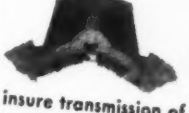
Same body . . . fits many pipe sizes by changing only liners!

One Body Fits Many Pipe Sizes: In contrast to many conventional slips where a completely new set of slips is necessary to change from one pipe size to another, interchangeable liners adapt the same "DU" Body to many sizes of pipe. For example, by changing only the liners, a 7" "DU" Body fits 4-¾", 5", 5⅝", 5-¾", 6", 6-⅝" and 7" pipe . . . seven different pipe sizes with one body!

Positive Slip Alignment: All segments work together as a unit. Even though off-center pipe pulls on one segment, others also drop in perfect alignment. Safeguards pipe. Speeds roundtrips.

Advanced Grip Design: Small truncated pyramids minimize pipe penetration. Also, grip area is relieved vertically and horizontally to eliminate stress concentrations that cause pipe damage.





Safety Liner Mounting: Liners held by deep recesses in body to insure transmission of all stresses directly to slip body. No bolts or pins to sheer and drop liners in hole. Yet liners are easily replaced with minimum effort!

Unique Flexible Hinge: Maintains rigid vertical alignment, yet permits lateral adjustment for perfect fit in master bushing bore.

utes, and a pitot tube measurement indicated 6,500,000 cu. ft. per day. A bottom-hole bomb showed a flowing pressure behind the choke of 1700 lb., so it was assumed that open flow would be much greater. After closing the valve and pulling the drill pipe, 1¼ stands of amber 44-deg. crude oil was recovered. Distillation test of the crude showed practically no light ends, a condition to be expected, due to the oil being purged by gas flow.

On completion of drilling, the lime was acidized in 4 stages, 500, 1000, 2000, and 5000 U. S. gal. of 15 per cent acid. Before acidizing an open flow test showed only 6,300,000 cu. ft. of gas per day and 46-deg. crude oil. This suggested that drilling mud had plugged the pores in the lime to some extent. After the 4 stages of acid a flow of 12,500,000 cu. ft. of gas a day was measured against back pressure at the surface of 380 lb. together with 78 bbl. per day of 51-deg. crude oil.

A series of back pressure tests showed that increasing back pressure gave increased gravity — up to 54 deg. water white oil, and as high as 93 bbl. per day with 1700-lb. pressure on the tubing, flow being through 30/64-in. choke at the surface. As gas production was 7,650,000 cu. ft. per day, the gas-oil ratio was 82,000 cu. ft. to 1 bbl. Under such high gas-oil ratios it is realized that this well would unduly deplete the reservoir energy, and it is not likely to be operated for oil production; however, it will afford an adequate supply of fuel in drilling further wells.

Bottom-hole pressure after the well had been closed in for 24 hr. was 3910 lb. and top-hole pressure was 2900 lb. On a build-up of several weeks the top-hole pressure has not increased, so it is assumed that the 24-hr. pressure represents reservoir conditions.

The various gravities and colors of oil closely resemble Turner Valley production under analogous conditions. Tests of Turner Valley oil show that it has an intermediate base, wax bearing, and it is presumed that Jumpingpound production will fall within a similar category.

Sulphur is present and a test suggests that the sulphur content will be much the same as in Turner Valley with considerably less sulphur than Turner Valley's maximum and somewhat more than Turner Valley's minimum. Sulphur occurs as hydrogen sulphide and as mercaptans.

▸ **Features of drilling equipment.** A 136-ft. steel derrick on a steel substructure rests on a reinforced concrete mat and houses the drawworks. Two heavy duty power pumps also stand on the reinforced concrete mat and the entire rig is powered by three internal-combustion engines using natural gas as fuel. The engines are connected to a compound transmission with chain drive to the drawworks and rotary table, and through clutches to the pumps.

Drill pipe, 4½-in. 18.10-lb., was used until 7-in. casing was set and protectors were kept on the portion inside 13-in. casing. After setting 7-in. casing, 3½-in. 13.30-lb. drill pipe was used. The footage made by this smaller drill pipe was not great, but some protectors were used although not a full set.

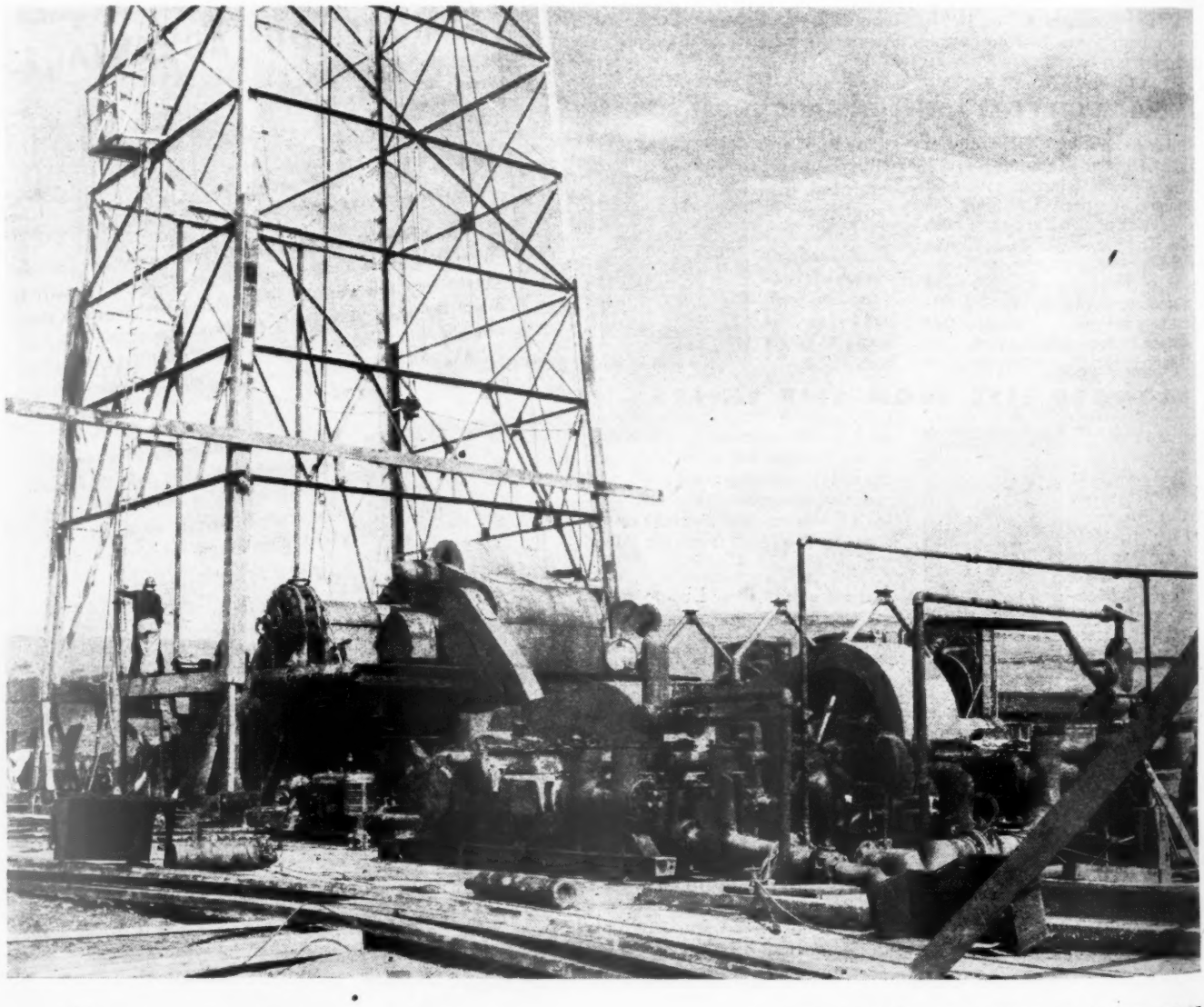
Drill collar arrangement was changed to suit conditions but the usual arrangement was two lengths of 40 ft. each.

Deviation tests were taken regularly. The greatest deviation was 3 deg. and that was for only a short distance.

A temperature survey was made to indicate the top of the cement and as a guide for future operations.

An electrolog was taken before the 7-in. casing was set and it proved a good check on formation samples.

Rigging up 4-24-J. Drawworks on floor are connected with transmission by covered chain drive. ***National Supply Company photo by Pollard.***



From the grass roots, 9-in. bits were used and the hole was reamed to 16 in. for surface casing. Casing of 13⅜ in. 48 lb. was set at 596 ft. and cemented with 300 sacks of construction cement. After the cement had set, 9-in. hole was continued into the top of the lime, when a string of 7-in. 26-lb. casing was set at 9636 ft. and cemented with 250 sacks, also construction cement. This puts the shoe 18 ft. into the lime and assures shutting out the more friable Fernie shale from having access to the open hole below.

Tubing of 3 in. I. D. 9.3 lb., external upset, was inserted to 9631 ft., with a packer at 9536 ft. to make a tight closure inside the 7-in. casing. Due to the depth, high pressure was anticipated, and to ease the strain on the casing the annular space between 3-in. tubing and 7-in. casing was filled with water.

Wellhead fittings. The wellhead fittings available locally were for a maximum test of 4000 lb., consequently special fittings for 10,000-lb. test were brought in from Los Angeles where they had been made in Shell machine shops. A truck with two drivers left Los Angeles on a Wednesday night and reached Coutts on the Montana border at 10:00 a. m. Saturday. There they were taken over by a Canadian truck and were landed at the well the same night.

The fittings include a flanged connection for the top of the 7-in. casing, and a flanged connection for 3-in. tubing, which bolts to the 7-in. flange. A 3-in. master gate valve bolted to the 3-in. flange is surmounted by a cross with flanges on the 4 outlets, machined from a solid steel block. Three 3-in. gate valves are bolted to the 3 outlets of the cross. The top connection provides a means for using a lubricator for inserting a pressure bomb, and the side outlets lead to a separator. One side outlet has a positive choke and the other an adjustable choke.

The separator is a high pressure unit, 36 in. by 16 ft. 6 in. with 750-lb. test. Two bolted oil tanks are each of 500-bbl. capacity.

In drilling this well to almost 10,000 ft., 266 bits, 9-in. diam., were used to the top of the lime and seventeen 6⅛-in. bits were used after the 7-in. casing was set. All were rock bits.

For the entire drilling job, which required 180 days, only 30,000,000 cu. ft. of fuel was used. This fuel consumption includes all fuel used in the camp, including fuel for cooking the drilling mud.

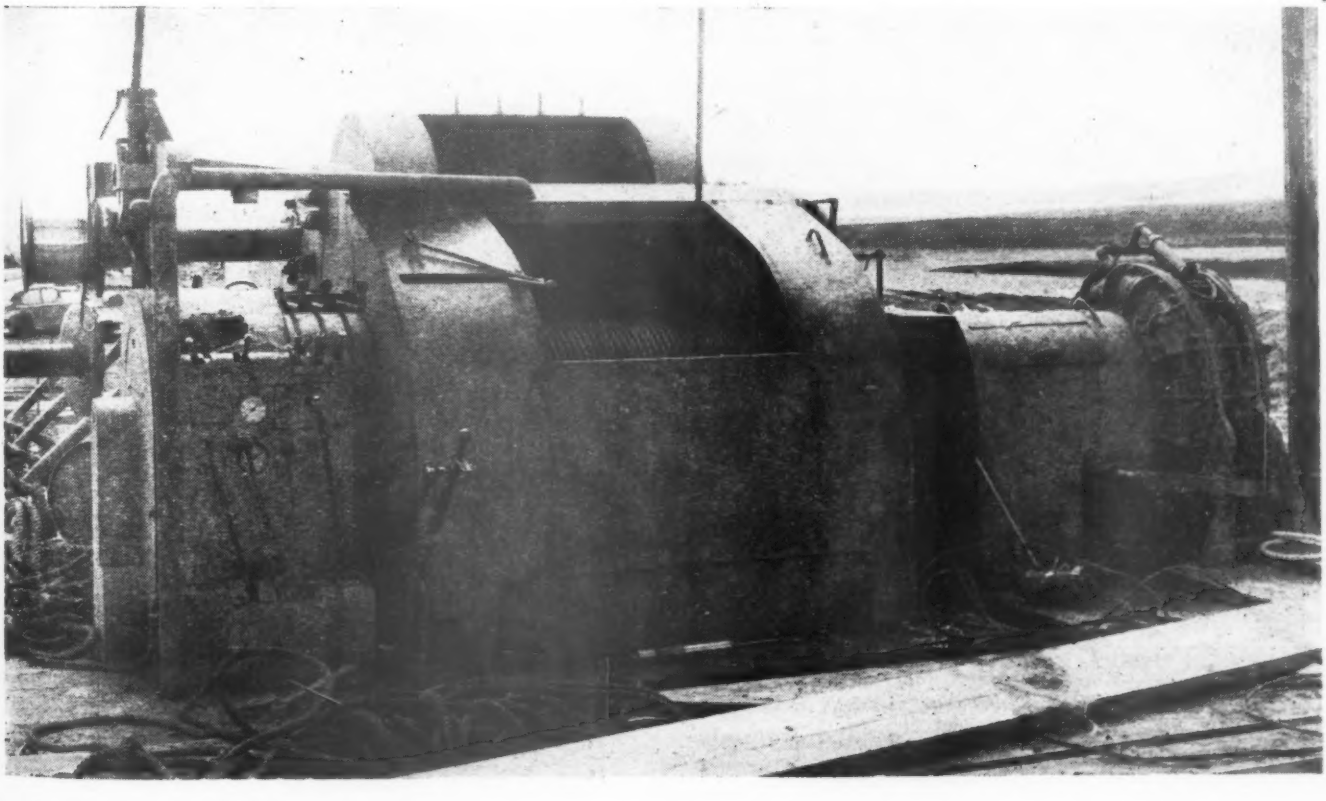
Many may raise their eyebrows at the mention of cooking drilling mud, as it is not a common practice in Mid-Continent fields; however, clay found near the rig proved to be very suitable for drilling mud once it had been conditioned by use of steam. Its viscosity is higher than bentonitic mud, and it picks up drill cuttings very well. Also, it does not jell on standing. While drilling the lime, however, bentonite was used in this well. Mud for horizons above the lime was maintained at a little under 80 lb. per cu. ft., and no artificial weighting material was used.

Leasing situation. News of the oil discovery broke in Calgary on Sunday, December 10. On Monday morning there was a scurry of "lease hounds" to the land office in the hope of picking up oil and gas rights under lands near the discovery or even on other foothills lands similarly situated as far north as Athabaska River. Shell had adequately protected its discovery, however, and open rights were few. Some leases in the Jumpingpound area changed hands, but they were not disposals by Shell, nor were they considered as being proved by the discovery well.

Extent of field. Based on the fact that within the 229 ft. of upper Rundle limestone penetrated there was evidence of gas cap and liquid phase oil, as well as other undisclosed seismic survey evidence, it seems quite probable that the attitude of the producing horizon is likely to be more nearly horizontal than most of Turner Valley, and hence the breadth of the field may prove to be greater. The length from north to south is not known, and if speculated on from seismic survey results, it has not been made public. It is fairly certain that salt water may be expected below the liquid phase zone, based on results at Shell Norman and on knowledge of Turner Valley conditions. It is also most improbable that there can be opportunity for access of meteoric water to the reservoir, so water drive is likely to be limited to elastic expansion of the connate water now in place as reservoir pressure drops. This implies that maximum oil recovery will be obtained by maintenance of pressure.

Shell 4-24-J is close to the confluence of Pile of Bones Creek with Jumpingpound Creek. It is said that in the days when buffalo roamed the plains, Indians erected a fence in the creek bottom to form a pound and drove buffalo over the cutbank into the pound. There is quite a pile of bones remaining from the butchering that ensued. Some innocents like myself think that Jumpingpound refers to the size and character of the trout to be found in the stream and this note is just to record the local reports of the origin of the names. ★ ★ ★

Closeup of drawworks at the Shell 4-24-J. ***National Supply Company photo by Pollard.***



Without Fail

It was early morning and raining lightly. The secret mission was ferrying two important Generals and their staff through enemy territory without fighter escort or guns. Flying no higher that 300 feet over the

ocean to escape enemy detectors these AAF flyers completed their mission without fail on a flight whose details are still secret from the enemy.

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Giant-sized cores as they were strung out beside the hole at Hillsboro, Texas. These chunks of core range from 3 to 4 ft. in length, weigh from 1500 to 2500 lb. each, and are 28 in. in diameter.

Lightweight, portable Failing model 1500 drill was used to produce the large cores shown in the accompanying photographs. This drill is almost an exact counterpart of the drill that is being manufactured for the armed forces for use in drilling water wells, except that the army drill uses a separate power unit.

PORTABLE DRILLING RIG REMOVES LARGE CORES

By **H. J. GODSCHALK,** George E. Failing Supply Company

A NOVEL system of exploring beneath the earth's surface preparatory to excavating for dams and bridges is being used by U. S. Army Engineers of the Galveston district in West Central Texas in connection with a survey of dam sites for flood control in the Colorado River basin.

Standing by to watch this new operation spectators are reminded of the age-old story of David and Goliath with the star role being played by a portable core drilling rig. This small, compact drilling rig*, designed to drill core holes from 2 to 6 in. in diameter, is performing the almost unbelievable feat of drilling holes 30 to 36 in. in diameter.

*Manufactured by the George E. Failing Supply Company, Enid, Oklahoma.

Not only are these large holes being drilled by this light, Failing 1500 drill but cores 28 to 34 in. in diam., ranging from 3 to 4 ft. in length, and weighing from 1500 to 2500 lb. each, are being removed from the holes.

The writer recently returned from a visit to Coleman, Texas, where the engineers have completed drilling some of these large core holes to a depth of 78 ft. The cores, 28 in. in diam., are lined up neatly beside the hole waiting for the dirt-removing contractors to come along and look them over.

The project at Coleman calls for a dam to be constructed across Hords Creek, in the Colorado river basin, about 10 miles west of the city. The dam when completed will be part of a national flood control project, and provide a new water supply for the city of Coleman.

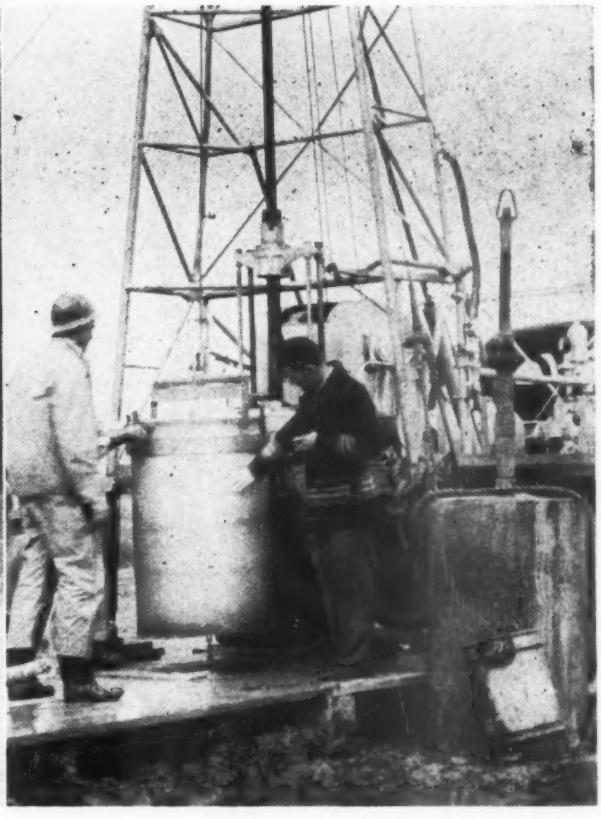
Hillsboro holes 138 ft. deep. Prior to going to Coleman the same group of engineers completed a similar project at Hillsboro, Texas. Three large core holes were drilled on the dam site. The deepest hole reached a depth of 138 ft. As at Coleman the cores were 28 in. in diam. The dam at Hillsboro will make a lake that is intended to be a link in the flood control program of the Brazos River, and it also will be utilized to furnish hydro-electric power for that section.

In addition to having the large cores

(Continued on Page 107)

Bridging ball above inverted valve seat. Shoe is in running position, with packer elements unexpanded.

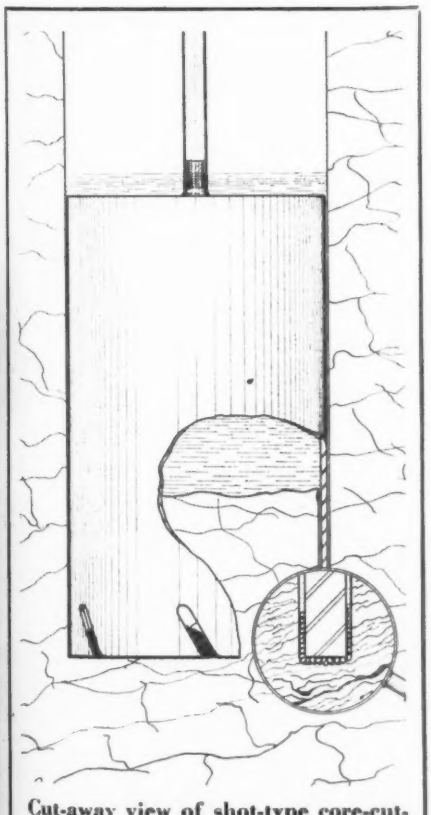
Ball seated, Bakelite sleeve has moved down, shearing pins, exposing side ports and expanding packer elements against wall.



Left—**The core at Hillsboro just after it had been removed from the hole by the drillers. The core barrel is shown at the extreme right of picture.** *Right*—**Core being removed from hole at Coleman, Texas. The man on the right is A. M. Hull, geologist in charge. This core is almost solid limestone. At top of the core can be seen the special lifting apparatus that is used to bring cores out of the holes.**

(Continued from Page 103)

available for contractors to inspect before submitting their figures and bids for moving the dirt for the dams, this new ultramodern method of coring provides opportunity for contractors to go down into the holes themselves and actually see what lies beneath the earth's surface at the very spot where they will have to work.



Cut-away view of shot-type core-cutting barrel showing how steel shot works under and around the lower edge during the rotary coring process. Slots accommodate excess shot. Formation particles float upward.

▸ **A personal trip down the well.** At the suggestion of the head driller (but not without some admitted qualms) the writer made a trip down the 78-ft. hole at Coleman. Sitting on a swinging seat to which ropes were attached he was let down into the hole by the winch attached to the drill. A light was supplied for foot by foot inspection of the formations on the way down to the bottom, and again on the way up to the surface. In other words, if the information from the cores is not sufficient, just don old clothes and a hard hat and have the driller lower away.

The inside of the hole was cylindrical and the wall firm and smooth. It was quite easy to see where one formation ended and another began.

The mechanical process of converting the small drilling unit into a machine capable of cutting these giant-sized cores is comparatively simple. Instead of the usual bit on the end of the drill stem, a barrel-like affair with slits in the end is attached to the stem and the usual rotary motion started. Steel shot are fed into the hole at intervals and provide the cutting medium. The cutting barrel is cooled by seepage, or a small amount of water may be poured into the hole occasionally, One core is usually cut on each tour.

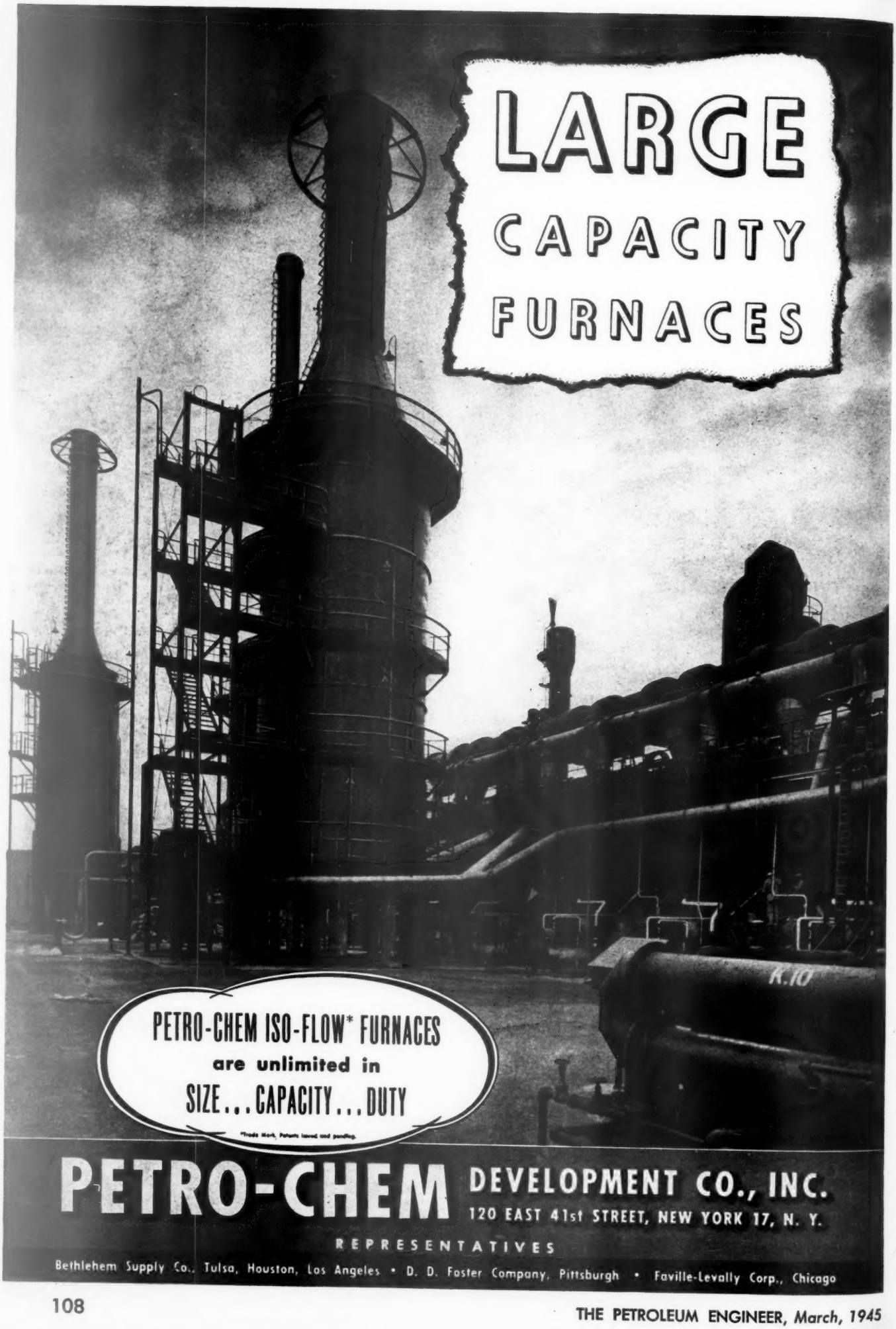
When a core the length of the barrel has been cut, the barrel is pulled to the surface empty and a driller is sent down into the hole. He wedges a metal ring around the freshly cut core and with another wedge breaks off the lower end of the core from the formation. The core is then hoisted to the surface and rolled out of the way.

▸ **Ripple marks found in a core.** Of special interest to geologists is the fact that a core taken at a depth of 60 ft. at Coleman had very clearly defined ripple marks on it, giving information from a geologic standpoint about the conditions under which the formation was deposited. This could not have been accomplished with a small core because the wave marks would not have shown so clearly, and probably would have been overlooked.

From Coleman the engineers will move to San Angelo and the size of the core holes will be increased 6 in. to 36 in. using the same Failing 1500 rig.

The work is being done under the direct supervision of A. M. Hull, geologist. He is being assisted by J. D. Bland, engineering aide.

Although large core holes have been drilled for various projects in the past, especially in the mining industry, this is one of the first instances where the work has been done so successfully with such a light rig. This drill is an adaption, in fact an almost exact counterpart, of the portable rigs built by the Failing company for drilling water wells for the armed forces overseas. ★★★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NEW FACILITIES INCREASE REFINERY OUTPUT

By **C. K. VILAND,** *Supervisor of Development*
Tide Water Associated Oil Company

PRESENT day aviation engines require specialized fuels. Such fuels must contain those types of hydrocarbons having desirable combustion characteristics that fall within the boiling range permissible in aviation gasolines. By present standards virgin gasoline distilled from crude oil is not a good fuel for high power aviation engines, and during recent years petroleum fractions have been chemically converted by ever-improving processes to better products from the standpoint of utilization in high compression aviation engines. One hundred octane is the present standard for manufacture of aviation gasoline in the United States.

One hundred octane gasoline is a fuel that, when run in a test engine, matches the anti-knock quality of chemically pure isooctane (2-2-4 trimethyl pentane, one of seventeen possible isooctanes). Aviation gasoline of 100-octane number is usually commercially produced as a blend of several ingredients, as shown in Fig. 1. It is customary to consider these in three classes, namely, the blending agents, including materials of higher quality than the average composition of 100-octane gasoline, the base stocks, or hydrocarbons of lower octane rating than the average of the blend, and tetraethyl lead, an additive that raises the anti-knock quality of all the hydrocarbon components and thereby permits inclusion of larger amounts of base stocks in the 100-octane blend.

Avon refinery—general. The Avon refinery of Tide Water Associated Oil Company is situated on the upper arm of San Francisco Bay in California and is about 4 miles from Martinez and 35 miles from San Francisco. It occupies an area of some 1444 acres and has ample dock facilities to load or unload ocean-going tankers.

The Avon refinery was one of a small number of plants producing 100-octane aviation gasoline before the war. Such aviation gasoline has been produced continuously since the completion of a sulphuric acid alkylation plant in June, 1940. New facilities recently placed in operation at Avon include the world's largest single fluid catalytic cracking plant, first placed on stream December 29, 1944, a pentane isomerization plant, the first of its type ever to be constructed, and further extensions to the alkylation plant. With the successful operation of new refining facilities present day production of 100-octane gasoline is well over 15 times that in 1940.

Aviation gasoline manufacture in this refinery utilizes a combination of processes that permit a maximum of flexibility in operation. In addition to the new facilities, the operation of all other refining units has been changed or affected by the pressing demand for increased quantities of aviation gasoline. The production from the older refining facilities that existed before the war has been an important contribution, and without them the present large production of aviation fuel and other war products would not have been possible.

Crude oil is received into the Avon refinery largely by pipe lines from the oil fields of the San Joaquin Valley. Natural gasoline is transported to Avon by tankers from the company's production at Ventura and from other gasoline pipe line terminals at tidewater.

Processing aviation gasoline. In manufacturing aviation gasoline, the Avon refinery carries out the following operations:

Distillation of light crude oil to obtain gasoline, residuum, and intermediate fractions. The intermediate distillates form part of the charge to the catalytic cracking unit. This operation is carried out in a conventional battery of stills and fractionating towers. The straight run gasoline from the crude stills and also the natural gasoline are charged to the superfractionation unit, which in effect sifts out the high octane components. The products from this unit are aviation base stocks, isomerization plant feed stocks, and solvent refining charge stocks.

The Avon superfractionator consists of a battery of 9 towers having from 36 to 70 bubble cap trays per tower. Although designed to separate narrow cuts of the isomers up to and including isoheptane, this unit often serves as a general purpose gasoline fractionator. For example, at times as many as 3 fractionators are employed in parallel separating isopentane from normal pentane. Under these conditions the superfractionated virgin base stock usually consists of a closely cut fraction containing isohexane, normal hexane, isoheptane, and other associated hydrocarbons naturally present in crude oil.

The heavier straight run naphthas produced by superfractionation are subjected to solvent refining to produce additional aviation base stocks rich in aromatic hydrocarbons. The Avon solvent refining plant is one of the first commercial units to have been installed in the United States. It was constructed in 1924 using sulphur dioxide as the solvent. A number of process changes have been made so that at the present time its throughput capacity is approximately 11 times the original design. The aviation base stock produced in this unit is similar in many respects to the intermediate cut of catalytically cracked gasoline.

The low octane raffinate from the solvent refining operation is thermally reformed, primarily to produce light olefins for alkylation feed and also charge stock for aviation base stock production by fluid catalytic cracking. A good example of war-time use of existing facilities is the use of the Avon No. 2 thermal cracking unit as a reforming unit to process this raffinate. This plant is being pressed at severity almost unheard of in prewar days, operating at transfer line temperature of 1110-1135°F. and producing 7 volume per cent of butylenes based on the feed stock on a once-through operation. Surprisingly enough, runs of 100 days are now not uncommon in this unit.

Cracking operations at Avon include thermal cracking of reduced crude and gas oils and thermal polymerization of refinery propane fractions, all under conditions suitable for production of alkylation feed stocks.

In the new fluid catalytic cracking plant gas oils and thermally reformed naphthas are processed under severe conditions in the presence of synthetic catalyst with the emphasis on the production of maximum quantity of alkylation feed stocks and maximum quality of gasoline, a large portion of which is used as aviation base stock.

Both the depentanized light catalytic naphtha boiling up to approximately 200°F. end point and the intermediate catalytic naphtha boiling in the approximate range of 220-340°F. are being acid treated commercially using about 15-20 lb. of spent alkylation acid per barrel of naphtha. The treating is done in two countercurrent refrigerated treating plants at a temperature of about 60°F. The treated light and intermediate catalytic naphthas are neutralized and rerun separately to remove the polymers formed from the lower octane olefins, leaving substantially only the higher octane isoparaffins and aromatics as the finished catalytic aviation base stock.

The Avon alkylation plant has 6 pump and time-tank propane refrigerated reactor units, 2 of which process feed stocks containing isobutane and amylenes as the major reactants. Four reactor units produce alkylate from isobutane, propylene, and butylenes. Of the olefins now alkylated, the butylenes and amylenes are produced by both thermal

and catalytic cracking and the propylene from catalytic cracking only.

To increase the supply of isobutane for wartime alkylation requirements, a vapor phase isomerization plant was constructed. This plant charges normal butane through a reaction zone containing isocel catalyst, of which the active ingredient is aluminum chloride. Anhydrous hydrogen chloride is used in the process as the reaction promoter. A high service factor is obtained in this plant, for it has 6 individually controlled tubular heat exchanger type reactors and 2 hydrogen chloride strippers.

The pentane isomerization unit is the first plant of its type ever to be constructed. This plant synthesizes isopentane, an important ingredient of aviation gasoline, from normal pentane. A liquid catalyst is employed, of which the active ingredient is aluminum chloride. The reaction is controlled by proper use of reaction promoters and suppressors, including hydrogen and hydrogen chloride.

All aviation gasoline components produced at Avon are blended in the refinery into 100-octane gasoline meeting government specifications. Other stocks, such as cumene and toluene, are also blended from time to time as they become available.

▸ **Processing other products.** Motor gasolines at Avon are produced largely from thermal cracking. Smaller quantities of naphtha from catalytic cracking and straight run gasoline fractions not used in aviation gasoline are blended into domestic and military motor fuels.

More than two-thirds of the capacity of the solvent refining plant is required in the manufacture of aromatic aviation base stocks and aromatic solvents. The rest of its capacity is used for finishing kerosines, lubricating oils, transformer oils, spray oils, cosmetic oils, and specialty products.

Asphalts and road oils are produced as by-products in the distillation of heavy crudes under vacuum during the manufacture of lubricating oils. Lubricating oils not finished by solvent refining are acid treated.

Domestic heating oils and diesel fuels are largely selected straight run fractions from the crude oil stills. Navy and industrial fuels are produced as the residues from cracking operations. One of the Avon thermal cracking units is specially designed to produce low-pour fuels from waxy crude bottoms through recracking a waxy distillate obtained from processing the visbreaker bottoms under high vacuum.

▸ **New fluid catalytic cracking plant.** A major installation is the fluid catalytic cracking plant, which has a design capacity to charge 16,000 bbl. per day of gas oil while cracking 72 per cent of the charging stock into gasoline and lighter fractions in a single pass through the reactor unit. The ability of the plant to circulate catalyst between the reactor and regenerator vessel is in excess of 40 tons per min., with coke burning capacity in the regenerator in excess of 16,000 lb. per hr. These severe cracking conditions make it possible to produce high yields of light isoparaffins and olefins for alkylation feed stocks and at the same time produce a gasoline rich in isoparaffins and aromatic hydrocarbons, which is finished by sulphuric acid treatment.

Commercial catalytic cracking of petroleum is a comparatively recent development, the first commercial plant to employ the fluid process having been completed in 1942. In its simplest form, catalytic cracking requires a catalyst to promote the reaction and some means of contacting the oil with catalyst. During the reaction the catalyst becomes fouled with carbonaceous material, which deposit is removed by combustion with air. In the fluid process a moving catalyst is used, with the reaction taking place in one vessel and the regeneration of the catalyst in a separate vessel. The fluid process takes advantage of the chemical engineering technique wherein powdered solids, such as powdered catalyst, are handled as a fluid by aeration with air or oil vapors. This produces a freely moving mass that can be circulated through the plant much in the same manner as a liquid.

The first catalytic cracking of the type known today may have occurred in a minor way incidental to clay treating of petroleum fractions. It is now generally known that many of the clays used for treating have some cracking activity. Of these clays, one type, known as bentonite, forms an active catalyst after having been treated with an acid. Montmorillonite, a non-swelling bentonite, has been used widely and is a hydrosilicate of aluminum with a well defined crystal structure. This is the type of catalyst used in all early catalytic cracking, being formed into pellets for use in the Houdry static bed process and the thermofor moving bed process, and used as a finely ground powder in the case of the fluid process.

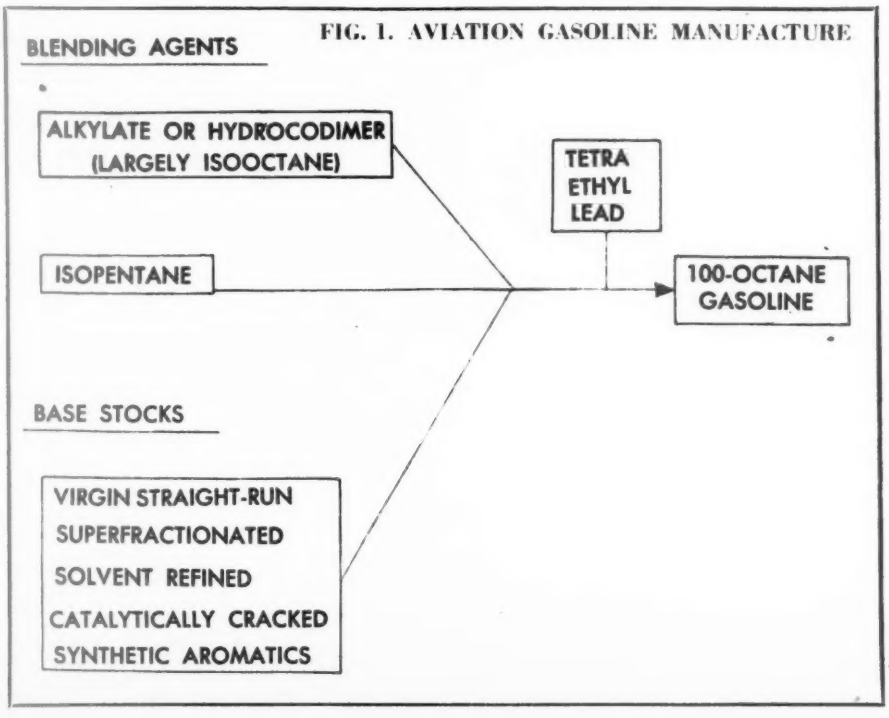
Research in catalytic cracking has led to the development of a synthetic cracking catalyst having a chemical composition similar to that of the clays, but which is more active and more stable at high temperatures than catalyst from natural sources. In addition to proper chemical composition, a cracking catalyst must be highly porous, and large surface area of these pores is important. A single pound of good cracking catalyst has approximately 50 acres of such surface. It is known that without this surface the white powder ceases to be a catalyst even though the chemical composition remains unchanged. The Avon plant uses a special finely ground synthetic catalyst manufactured by the American Cyanamid and Chemical Corporation.

In the Avon fluid catalytic cracking unit no furnace is needed for preheating the charge oil. The oil reaches the temperature required for the reaction from heat imparted to the moving catalyst in the regeneration step. After combustion, catalyst at about 1050°F. or higher temperature flows from the regenerator into the reactor riser pipe where it is contacted with the fresh oil charge, which has been preheated to approximately 400°F. through heat exchange. The oil, which is substantially completely vaporized instantly upon contact with the hot catalyst, passes into the reactor vessel where a suitable bed depth of fluidized catalyst is maintained.

The Avon reactor is unusually large, dimensions of the cylinder portion being 27 ft. in diameter by 54 ft. high on the straight side, which with a 45 deg. cone top and bottom provides ample capacity for maintaining high cracking intensities at design or higher charging rates. The bulk of the entrained catalyst in the oil vapors passing out of the reactor is recovered in the Multiclone unit and returned to the system. The cracked oil vapors are charged to the 17-ft. 6-in. by 89-

(Continued on Page 114)

FIG. 1. AVIATION GASOLINE MANUFACTURE



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CATALYTIC REFORMING	*THERMAL REFORMING*	*POLYTREATING*
HYDROGENATION	*HYDROFORMING*	*U. O. P. CATALYSTS*
ALKYLATION	*DEHYDROGENATION*	*UNISOL TREATING*
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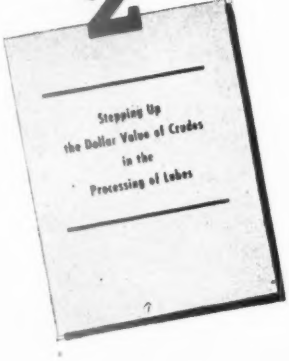
2



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3

KELLOGGRAM...the Fluid Catalytic-Cracking Process—How it Operates

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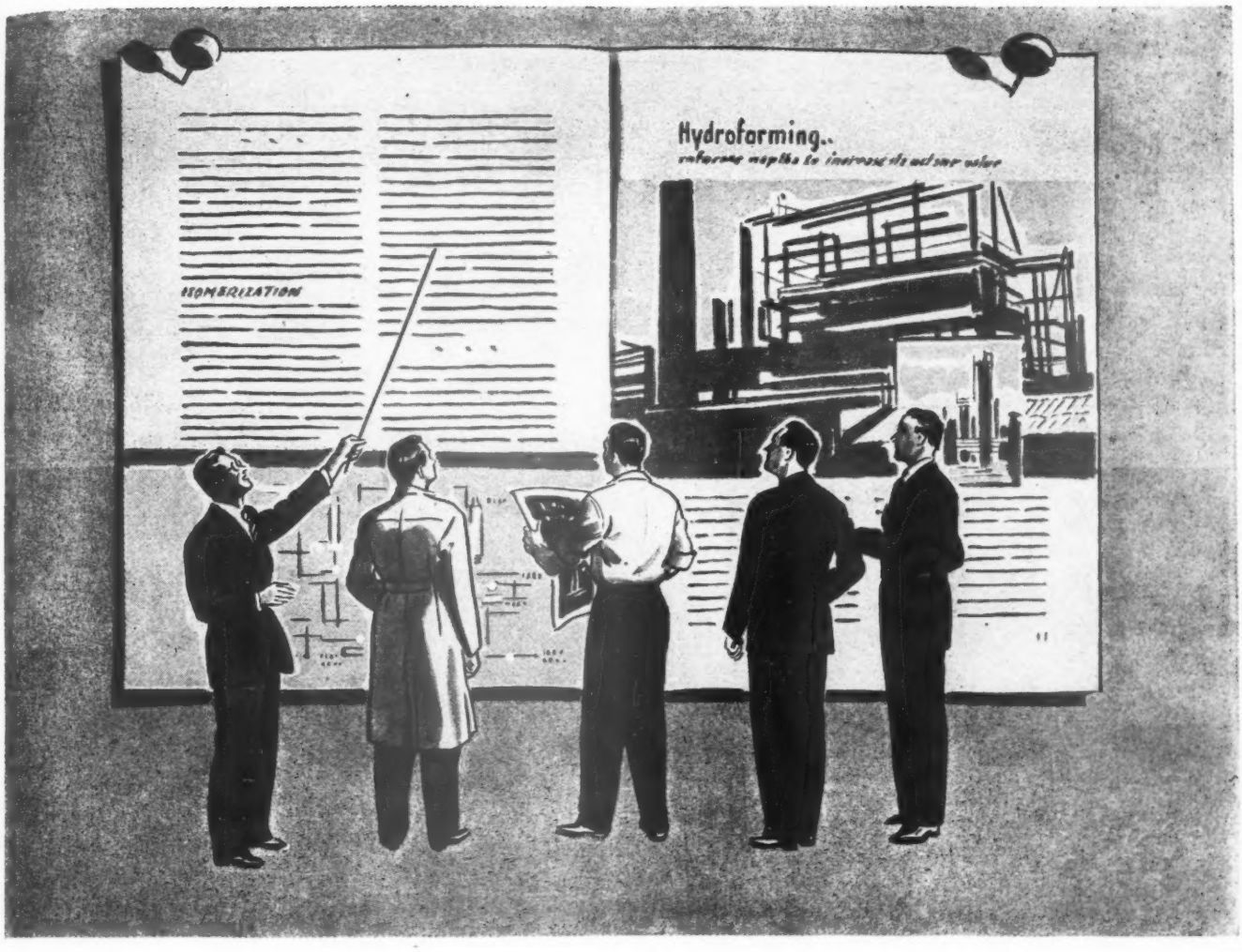

COPIES of this current "required reading" have been mailed, of course, to every executive and technical man on The M. W. Kellogg Company's list. But if for any reason, you have not as yet received your copies, please write us for same and we will forward them to you immediately.

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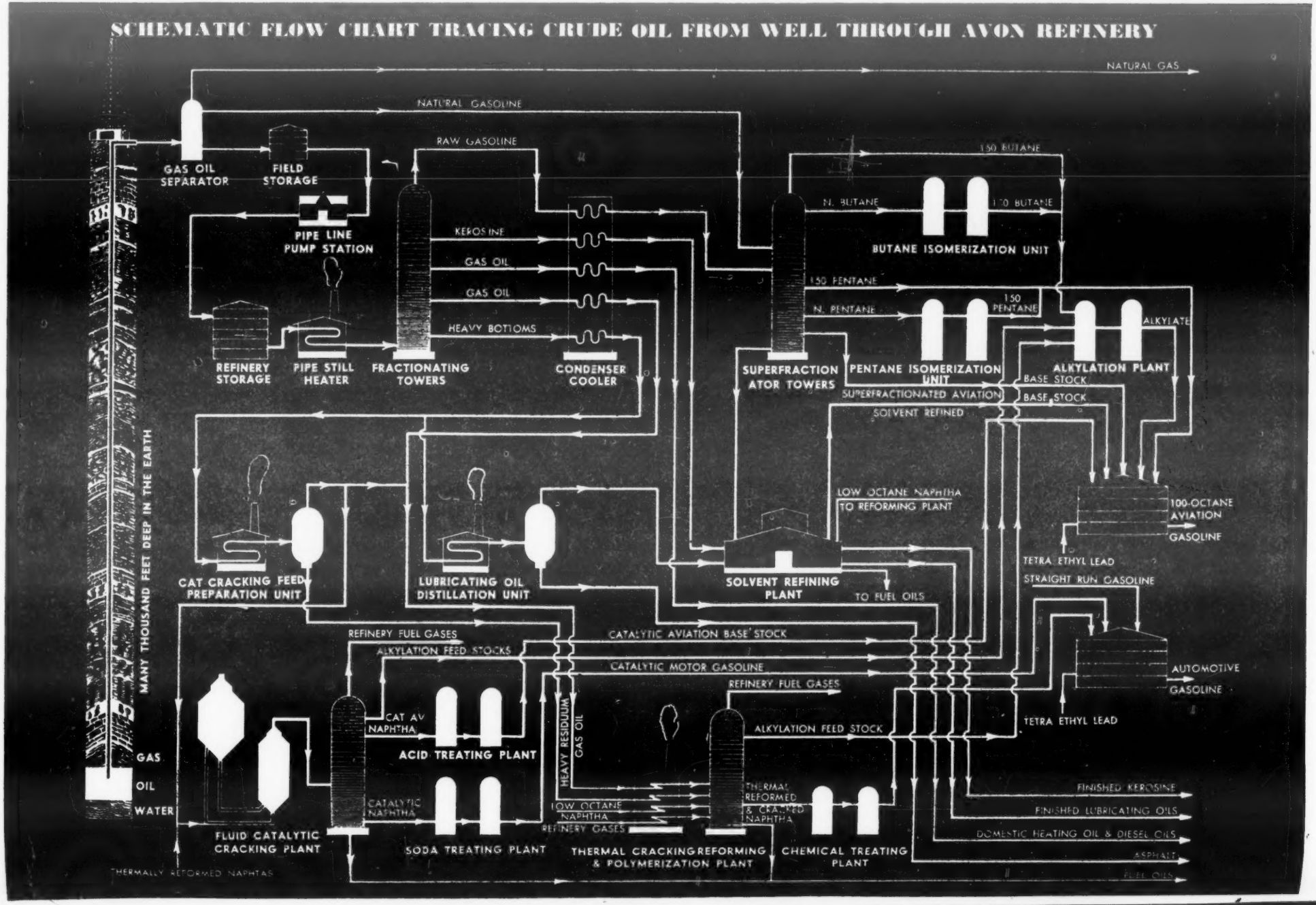
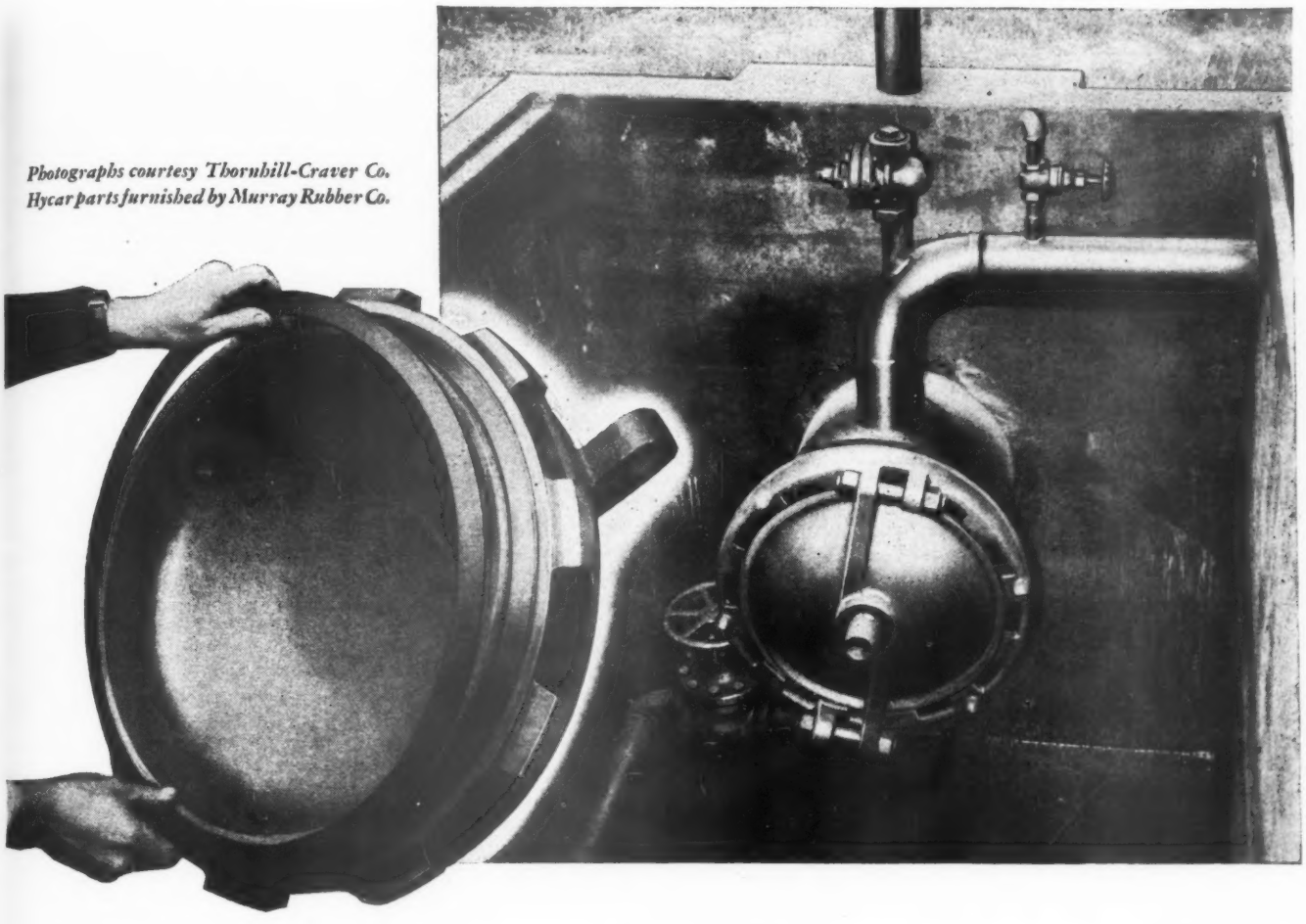
(Continued from Page 110)

SCHEMATIC FLOW CHART TRACING CRUDE OIL FROM WELL THROUGH AVON REFINERY



Photographs courtesy Thornhill-Craver Co.
Hycar parts furnished by Murray Rubber Co.



Hycar keeps a pipe-line's trap shut

EVERY oil man probably knows that Unibolt Scraper Trap Couplings are in service on many major oil pipe-lines. But they may not know that Hycar synthetic rubber sealing rings now play an important part in the success of this device. The manufacturer had a coupling that could easily and quickly be removed and installed. Its performance depended on a resilient ring that would maintain a positive seal, one that would resist oil and keep its shape, one that would not stick to metal and slow down removal of the cover plate.

Hycar was obviously the answer. First, its superb oil resistance has made it almost the standard resilient material in all oil field work. It's known, too, as the resilient material that *stays* resilient. Hycar won't get gummy or tacky, nor will it vulcanize itself to metal. And it holds its shape almost indefinitely.

Other important Hycar properties are shown in the box at the right. They tell why Hycar is the ideal material for gate packers, mud line valves, oil well tubing packers, blow-out preventers, gaskets and hose of all kinds and many other products where these properties are essential. Ask your supplier for parts made of Hycar.

Free — Write Department U-2 for your copy of "Everywhere in Industry", the new booklet describing Hycar's characteristics, with full technical data. *Hycar Chemical Company, Akron 8, O.*

What Hycar Does in Oil Field Applications

1. Resists oil and gas—even under high pressures and temperatures.
2. Resists action of abrasive-laden fluid under high pressure and at high velocity.
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Synthetic Rubbers

ft. fractionating tower, where separation of the catalytically cracked products is obtained. Both the reactor and fractionator are alloy lined to permit operation on a variety of feed stocks. The spent catalyst drops through the reactor past the inlet distributor grid section and into the bottom cone, which serves as a stripping section to remove entrained oil vapors by steam purging before the catalyst is transferred into the regenerator vessel. At the bottom of the reactor standpipe a slide valve is provided that regulates the flow into the 92-in. regenerator riser pipe. This line has no horizontal sections.

The regenerator vessel has an effective diameter of 46 ft. and a cylinder height of 30 ft. after allowing for the space occupied by the Bigelow-Liptak refractory lining. The regenerator vessel also has a 45 deg. cone top and bottom, and is equipped with a meehanite distributor grid and 2 regenerated catalyst draw-offs, one for the regenerated catalyst return to the reactor and the other for the recycle catalyst steam generator exchangers, which act as a temperature controller. The flue gases leaving the bed of fluidized catalyst in the regenerator pass through Multiclones and through twin waste heat boilers and into the Cottrell precipitator units, which are operated at substantially atmospheric pressure. These units recover catalyst fines from the flue gas.

▸ **Feed preparation unit.** In order to augment the supply of virgin gas oil from the Avon crude oil distillation units, a vacuum feed preparation unit was built and is operated in conjunction with an existing thermal viscosity breaking unit. Straight run residuum from the crude stills, containing waxy gas oil, is charged through heat exchange on the viscosity breaking unit into a new 50,000,000 B.t.u. per hr. fired tubular heater designed to operate at transfer line temperatures of up to 690°F. The transfer line enters the bottom section of a vacuum tower, which is 24 ft. in diam. and 22 ft. high on straight side. It is designed to operate at 50 mm. mercury absolute pressure in the flash section. This vacuum tower is provided with 4 specially designed fractionating trays and has a design charge capacity of 25,000 bbl. per day of residuum, with the ability to take overhead 10.000 bbl. or more per day of well fractionated oil This product forms part of the charge to the new catalytic cracking plant, and the heavy residuum bottoms are thermally cracked in the adjacent 2-stage viscosity breaking unit.

▸ **Gas recovery stabilization unit.** The gas recovery stabilization unit provided for the new catalytic cracking plant processes both the liquid and the gas products from the main fractionating tower. Five 800-hp. Clark compressors take suction on wet gas from the distillate condenser at substantially atmospheric pressure, raising the pressure to approximately 40 lb. gage in the first stage of compression.

A feature of novelty in the Avon gas recovery plant is the provision of a water wash tower to cleanse the gas after the first stage of compression and also the raw gasoline from the main distillate receiver in an 84-in. by 24-tray column. This provides the ability to process gas oils that might be high in nitrogen compounds, removing products of cracking that may affect efficient operation of the gas plant towers. Each engine is provided with both low and high stage gas compression cylinders so that each compressor is a self-contained unit.

The washed gas is picked up into the suction of the second stage cylinders and boosted to a pressure of 175 lb. gage, where it enters a 40-tray absorber-demethanizer column. The raw gasoline from the water wash tower bottoms enters the lower section of the absorber-demethanizer, and sufficient absorption oil is circulated over the top of the tower to recover 70 per cent or more of the propane-propylene fraction and substantially all the heavier hydrocarbons. An intercooler is provided near the center of the absorber, and the bottom section is provided with a reboiler to eliminate as much methane and ethane as possible from the rich absorption oil before further processing.

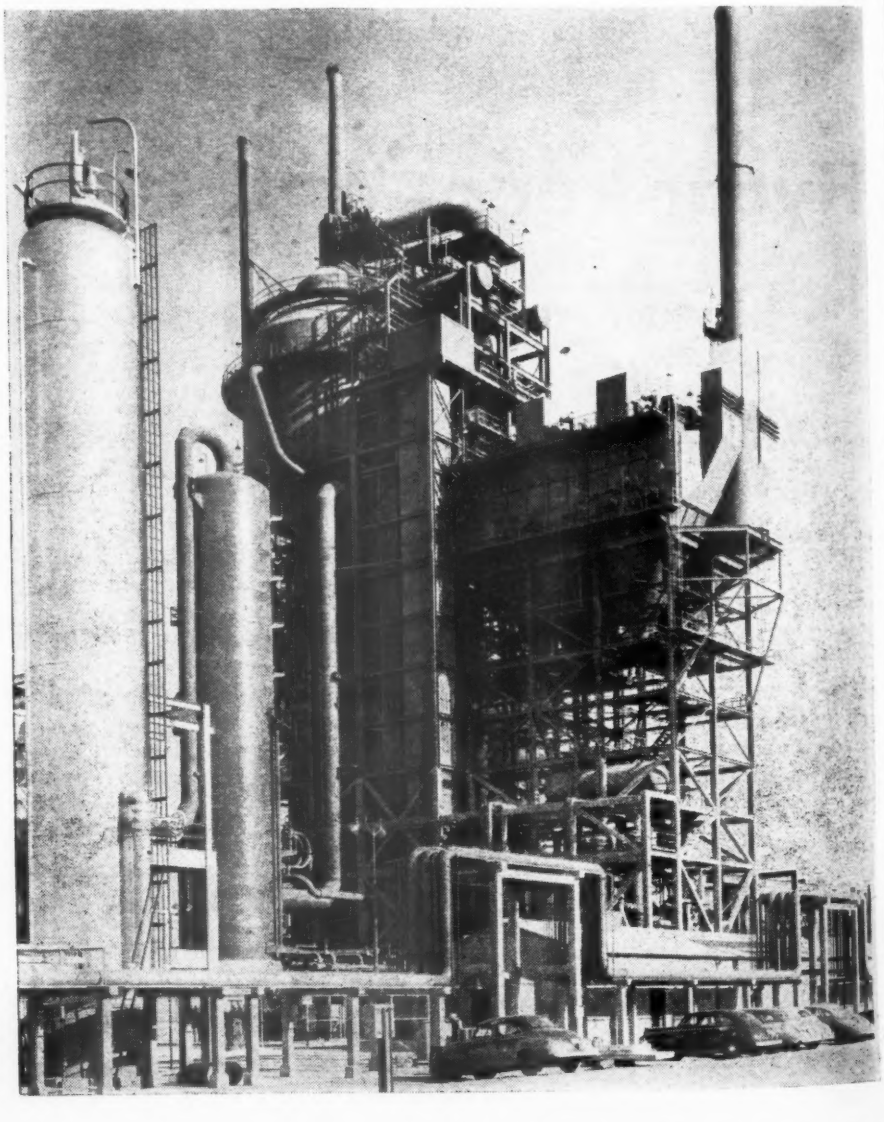
The rich oil is charged into a 30-tray still, where an overhead fraction of about 200° F. end point is recovered. This fraction is charged into a 40-tray depropanizer tower, taking overhead the propane-propylene cut, which is further processed for hydrogen sulphide removal in a Girbotol purification unit. The bottoms from the depropanizer tower are charged into a 40-tray debutanizer-dependanizer tower for recovery of alkylation feed stocks, and light catalytic naphtha is removed as the bottom product.

The bottoms from the still, comprising the material largely in the range of 200-400°F., are split into 2 streams, part going to the absorber demethanizer as absorption oil and part to a 30-tray splitter column where a 200-340°F. aviation naphtha cut is taken overhead and heavy motor naphtha removed as the bottom product.

All new facilities were constructed by C. F. Braun and Company as Tide Water Associated's contractor. The butane and the pentane isomerization units are operated under license from Shell Development Company. The fluid catalytic cracking unit is licensed by Universal Oil Products Company, which supplied process engineering and cooperated with Braun's and Tide Water Associated's technologists in the design of the unit.

★★★

Fluid catalytic cracking unit



Annual
PIPE LINE NUMBER
1945

DESIGN OF OIL PIPE LINES

By **FRITZ KARGE,** *Chief Engineer, Pipe Line Department*
Union Oil Company of California

EXCLUSIVE THIS article, in somewhat different form, was first delivered by the writer as one of a series of lectures at the University of Southern California, Los Angeles, War Training Program, Course No. 3113, P. L. Armstrong, instructor. Permission to use material presented in this course is hereby gratefully acknowledged.

The article deliberately does not delve into first causes of hydraulics; rather it accepts the painstaking work of scientists and engineers who brought forth formulas based on approximate theory but rectified by coefficients from experimental data. They have stood the test of time, if this term can be applied to a period of 40 to 50 years. Further refinements in the recognition of certain hydraulic phenomena are desirable and challenging. The ability, for instance, to predict more accurately the flow behavior of a cooling liquid between the upper and lower critical flow limits would be of value to the designing engineer.

The purpose of the article is to give a brief outline of the most important factors required for the design of oil pipe lines. It offers a graph (Graph 1) of "Friction Factors for Commercial Pipe" that is based on the article "The Flow of Fluids in Closed Conduits" by R. J. S. Pigott. The graph varies from the article only in some of the symbols for physical quantities. It will be referred to hereafter as the Pigott graph. A second chart is appended, "Friction Factor Chart for Fluid Flow in Pipes," also accepting Pigott's work but presenting formulas more conveniently manipulated on the slide rule. The chart is hereafter referred to as Graph 2.

Pigott's paper is to be found in "Mechanical Engineering," August, 1933. It summarizes the meat of an article by Emory Kemler, *Transaction* American Society of Mechanical Engineers, 1933, paper HYD 55-2. Kemler's work contains the most thorough critical comparison of flow test data ever undertaken. "From 10,000 to 12,000 individual tests were studied; all those in which the data were noticeably incomplete or subject to doubt were discarded. In the final work, approximately 4000 test points were used, from about 200 separate test series." Test data from operating oil pipe lines were included. The work of Kemler and Pigott has been accepted by many engineers and authorities in hydraulics.

Well known engineer discusses those factors considered most important to proper construction of oil transportation system.

It is assumed that the reader is familiar with the term "streamline" flow, also called direct, laminar or viscous, and with "turbulent" flow, often called sinuous. It is further assumed that the reader is acquainted with the several systems in use for denoting the viscosity of liquids.

Before presenting the practical aspects of pipe line design, it appears desirable to review the most important flow formulas and their application; to dwell upon the function of the various factors, and to discuss the probable accuracy of the formulas.

▸ **Flow formulas.** The Pigott chart, as offered, lists a number of flow formulas using different factors, such as velocity of flow in feet per second, mass velocity in pounds per second, quantity flow in gallons per minute or barrels per hour. The pipe diameter is expressed in inches or feet, the viscosity in centimeter-gram-second units (c.g.s.) or in pound-foot-second units (p.f.s.). These and other formulas are in use and may be encountered on friction factor graphs published in magazines or technical books. If the formulas are set side by side and if the different factors are converted to one single system of measurement, all will give the same end result. This must be so, for all are based on the same fundamental equations.

The formulas for streamline flow of oil follow the experiments of Poiseuille.

GRAPH 1. FRICTION FACTORS FOR COMMERCIAL PIPE

(Key table on opposite page)

Reynolds number of flow in pipes.

$$R_e = \frac{Dvp}{\mu_e} = \frac{124dvp}{\mu} = \frac{50.7Qp}{d\mu} = \frac{6.32W}{d\mu}$$

$$R_e = \frac{35.5Bp}{d\mu} = \frac{7742dv}{\nu} = \frac{3162Q}{\nu d}$$

Pressure drop for viscous flow conditions (Reynolds numbers less than 1200):

$$\Delta P = P_1 - P_2 = \frac{0.000669\mu Lv}{d^2}$$

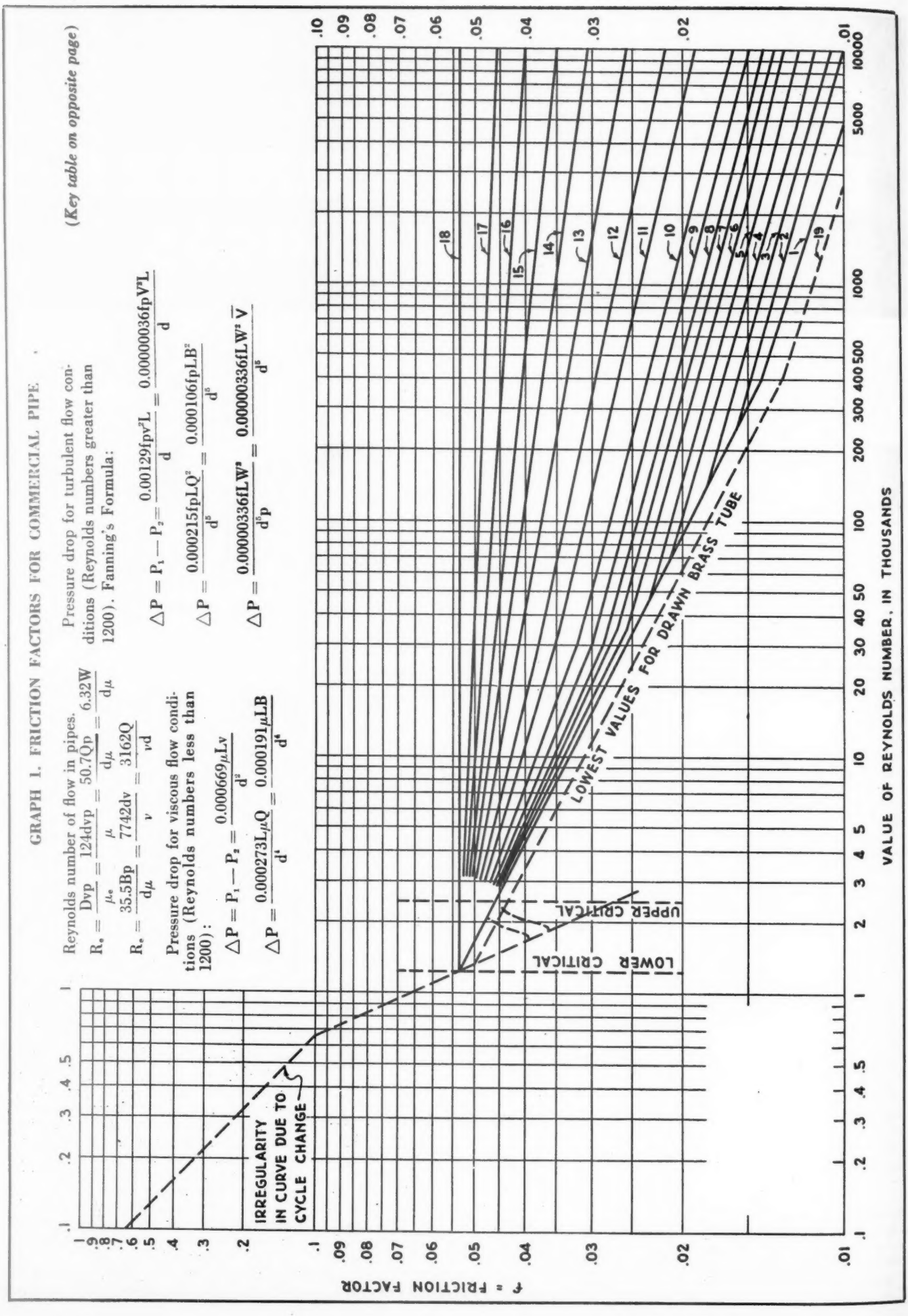
$$\Delta P = \frac{0.000273L\mu Q}{d^4} = \frac{0.000191\mu LB}{d^4}$$

Pressure drop for turbulent flow conditions (Reynolds numbers greater than 1200). Fanning's Formula:

$$\Delta P = P_1 - P_2 = \frac{0.00129fpv^2L}{d} = \frac{0.00000036fpV^2L}{d}$$

$$\Delta P = \frac{0.000215fpLQ^2}{d^5} = \frac{0.000106fpLB^2}{d^5}$$

$$\Delta P = \frac{0.00000336fLW^2}{d^5p} = \frac{0.00000336fLW^2\,\overline{V}}{d^5}$$



Key table

Curve no.	Roughness, per cent	Diameter of pipe in inches					
		Type A	Type B	Type C	Type D	Type E	Type F
1	0.2	0.35 up	72	...	...	...	....
2	0.45	...	48 to 66	...	...	...	....
3	0.81	...	14 to 42	30	48 to 96	96	220
4	1.35	...	6 to 12	10 to 24	20 to 48	42 to 96	84 to 204
5	2.1	...	4 to 5	6 to 8	12 to 16	24 to 36	48 to 72
6	3.0	...	2 to 3	3 to 5	5 to 10	10 to 20	20 to 42
7	3.8	...	1½	2½	3 to 4	6 to 8	16 to 18
8	4.8	...	1 to 1½	1 to 2	2 to 2½	4 to 5	10 to 14
9	6.0	...	¾	1¼	1½	3	8
10	7.2	...	2	1	1¼	...	5
11	10.5	...	⅝	¾	1	...	4
12	14.5	...	½	½	...	...	3
13	19.0	...	⅜	...	...	...	....
14	24.0	0.125	...	⅜	...	...	....
15	28.0	...	...	...	...	...	....
16	31.5	...	...	¼	...	...	....
17	34.0	...	...	...	...	...	....
18	37.5	0.0625	...	⅛	...	...	....

Type A—Drawn tubing and brass, tin, lead, and glass pipe.
Type B—Clean steel and wrought iron pipe.
Type C—Clean galvanized pipe.
Type D—Best cast iron pipe, cement and light riveted sheet ducts.
Type E—Average cast iron pipe and rough formed concrete ducts.
Type F—First class brick heavy riveted and spiral riveted ducts.
Note: In drawn tubing the actual inside diameter is given. In pipe, the nominal size of standard weight is given.

Fanning's formula for water underlies all given formulas for turbulent flow and the friction coefficient "f" in Fanning's formula is found by determining the Reynolds number, which by its magnitude indicates whether the flow is streamline or turbulent. The friction factor is the same for the same values of the Reynolds number and for the same size and kind of pipe irrespective of the nature of the fluid flowing in the pipe.

If an engineer is frequently called upon to design oil pipe lines, whether short ones for a refinery plant or longer ones for an oil field, or wherever long lines are needed, it seems advisable for him to make himself thoroughly familiar with one formula for streamline flow and one for turbulent flow, and then to lay aside all others. Which formula is he to choose?

The writer's experience has led him to the adoption of formulas in which the flow rate is expressed in barrels per hour. The reasons follow:

The capacity of a refinery plant is usually given in barrels per day, and the flow sheets for such plants use that flow rate for all interconnecting pipe lines more frequently than gallons per minute, pounds per hour, or other systems of measurements.

The capacity of an oil well or of a whole field is usually expressed in the same term, namely, barrels per day.

When designing a tanker loading or unloading line, the flow requirements will usually be stated in barrels per hour.

Barrels per day is easily changed to barrels per hour, and this term is understood by all men engaged in oil operations, whether they pump oil wells, gage tanks hourly at a pump station to record the number of barrels handled during the previous hour, control the flow of oil to or from a still or other refinery unit, or whether they supervise the filling or emptying of a tanker.

No potent reason seems to exist for complicating design calculations by changing the barrels per hour term to gallons per minute, pounds per hour, feet velocity per second or some other system. Why not use the term in which the capacity requirement of the pipe line will very likely be stated?

It further seems that design calculations should be made uniform by expressing the viscosity in the terms approved by the American Standards Association and American Petroleum Institute in 1939 and shown in the accompanying table which is reprinted from the publication of the American Society for Testing Materials. This publication gives the approved method for converting Saybolt universal viscosity in seconds to kinematic viscosity. It adopts the following nomenclature:

Absolute viscosity is expressed in poises (c.g.s unit) or centipoises.

Kinematic viscosity, being equal to the absolute viscosity divided by the specific gravity, is expressed in stokes or centistokes. The stoke is here also the c.g.s. unit.

A measure of simplification results from the adopted practice, for the descriptive adjectives "absolute" and "kinematic" are unnecessary, being implied in the terms "poises" and "stokes," respectively.

When a sample of oil is sent to the laboratory for the determination of its viscosity, a Saybolt viscosimeter will very likely be used, or an Oswald viscosimeter. The viscosity will be reported in Saybolt universal seconds units for light oils and in furol units for heavy oils. Conversion of the Saybolt viscosity to kinematic viscosity in stokes is easy when Table 1 is used, or any of the many conversion charts. The kinematic viscosity in stokes, multiplied by the specific gravity at the same temperature, gives the absolute viscosity in poises.

The absolute viscosity of water at 69° F. is 1 centipoise. The centipoise viscosity value of an oil, therefore, indicates how many times stickier the oil is than water. Although not much value lies in the knowledge of this relationship, it is of interest. The poise was named in honor of Poiseuille, who gave to the world the formula for streamline flow.

As previously stated, the formulas hereafter presented are those that the writer has found most simple to manipulate. As far as he knows they were first employed by Danforth, referred to below. As will be pointed out, they permit the designer to visualize readily the effect upon the result of a change in any one of the factors. They are not given for the purpose of persuading the reader to adopt them for use, rather to show how any one of the several flow formulas on the Pigott graph (Graph 1) can be juggled to one that the reader will find practicable. The problems can also be solved by means of the many diagrams designed and issued by various engineers. Some of them have a separate diagram for each of the commonly used commercial sizes of pipe. The best known of this type is the set worked out by R. S. Danforth for the Kinney Manufacturing Company, published in 1920. The pressure drop per 1000 ft. of pipe read on these diagrams is on the safe side. Other published graphs combine all sizes of pipe on one sheet. They are less simple to read and interpret. Crane Company presents in Technical Paper No. 409 of May, 1942, a set of nomographs for taking off the pressure drop for streamline and turbulent flow. This paper contains also a good bibliography of papers and books for a more detailed study.

The writer uses such charts for quick estimates of pressure drop or for checking calculations. He does not use them for design purposes because no record is left of the progressive steps in the solution of the problem. Most charts, furthermore, are designed for standard weight pipe. Corrections must be applied when lighter weight pipe is under consideration.

Any engineer is at liberty also to design a diagram to his particular taste. He will find it stimulating entertainment that will give an insight into the mathematics involved and an acquaintance with the effect of changes in the value of the various factors that otherwise can be gained only by many design calculations.

The writer will return to this subject later, and it is hoped that the several emphases laid upon the desirability of thoroughly acquainting oneself with the mathematics of flow formulas will enable the designer, if followed, to use this tool with skill and understanding.

▶ **Streamline flow.** The simplest formula is one adopted from Poiseuille's*, reading as follows:

$$P = \frac{19.1\,Q\,z}{d^4}$$

In which:

P = lb. pressure per sq. in. per 1000 ft. of pipe line. For other lengths, P is proportional.

Q = bbl. per hr. of 42 U. S. gal.

z = absolute viscosity in poises.

d = inside pipe diameter, in.

(The writer pleads guilty of inconsistency in employing the letter Q as the symbol for barrels per hour and z for absolute viscosity in poises, whereas the Pigott graph uses B and the Greek letter mu, respectively.)

For some purposes it is more convenient to express the friction loss in feet head. The formula then reads:

$$H = \frac{44.12\,Q\frac{z}{s}}{d^4}$$

In which:

H = ft. of head per 1000 ft. of pipe.

$\frac{z}{s}$ = kinematic viscosity in stokes.

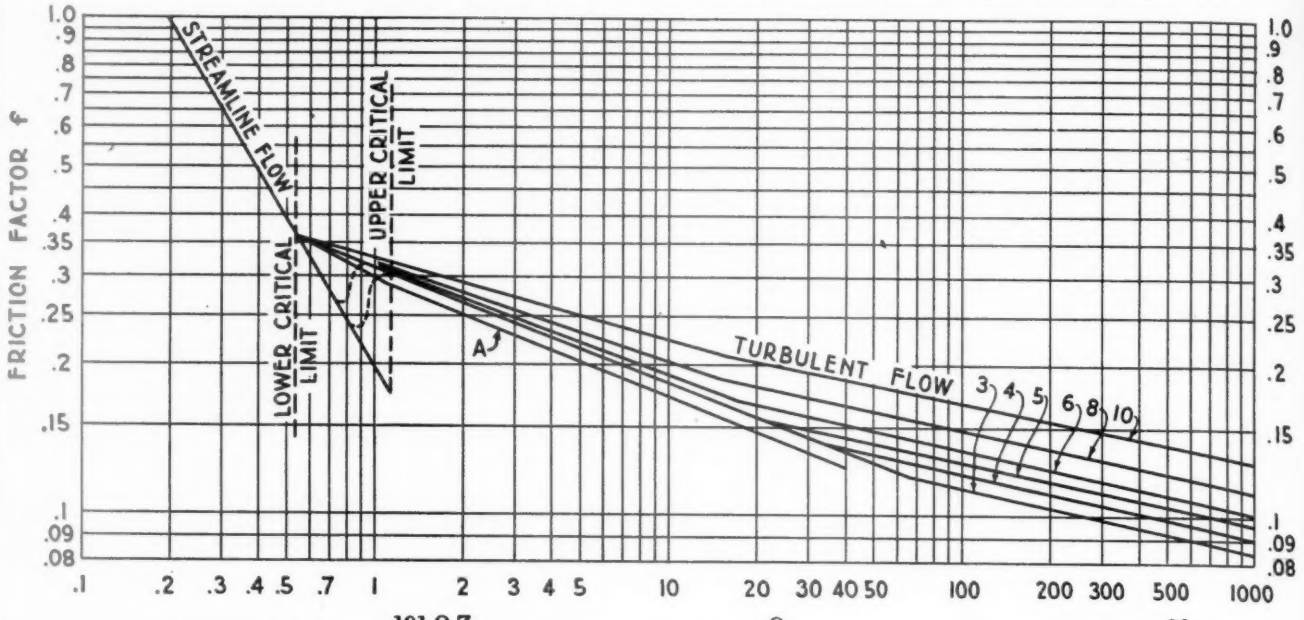
There is no need to show the derivation of these formulas here. They are merely transpositions of the third for-

*Poiseuille's classical "Experiments on The Flow of Liquids in Capillary Tubes" (1842).

VALUE OF REYNOLDS NUMBER, IN THOUSANDS

GRAPH 2. FRICTION FACTOR CHART FOR FLUID FLOW IN PIPE LINES

References: 1. The flow of fluids in closed conduits—R.J.S. Pigott, *Mech. Eng.*, Aug., 1933.
2. A study of the data on the flow of fluids in pipes—Emory Kemler, *Trans., A.S.M.E.*, 1933, Hyd.—55-2.



For streamline flow $P = \frac{191\,Q\,Z}{d^4}$ Reynolds number $R = \frac{Q}{d\frac{z}{s}}$ For turbulent flow $P = f\frac{sQ^2}{d^5}$

P = pressure drop per 1000 ft. — lb. per sq. in.
f = friction factor
s = specific gravity of fluid at flow conditions
Q = quantity — bbl. per hr.
d = actual pipe diameter — inches
z = absolute viscosity — centipoises
$\frac{z}{s}$ = kinematic viscosity — centistokes

3 = Pigott curve for 14" 42" steel pipe
4 = Pigott curve for 6" 12" steel pipe
5 = Pigott curve for 4" 5" steel pipe
6 = Pigott curve for 2" 3" steel pipe
8 = Pigott curve for 1" steel pipe
10 = Pigott curve for ½" steel pipe
A = Std. Oil of Cal. and Wm. G. Heltzel Curve (average) 6"—12"

mula for viscous flow on the Pigott chart. Attention is called to the fact that P varies directly as Q and z, and inversely as the fourth power of the pipe diameter. The effect upon P of a change in the magnitude of the flow rate, viscosity or pipe diameter can, therefore, easily be visualized and calculated, if desirable. H is similarly affected, varying directly with Q and $\frac{z}{s}$ and inversely as the fourth power of the pipe diameter.

Expressing the viscosity in centipoises, the constants in the given formulas will become 0.191 and 0.4412, respectively.

Reynolds number.** The formulas were given before mentioning the test that must be made to assure the reader of their applicability to the design problem before him. As they apply only to pipe lines in streamline flow, it is first necessary, by means of the Reynolds number, to determine the condition of flow for the quantities involved.

Again the question arises which of the several formulas presented on the Pigott graph (Graph 1) to use. Following previous reasoning, it appears best to become thoroughly familiar with one formula and that the simplest. Graph 2 with formulas, designed on the basis of the Pigott graph, meets all requirements of simplicity. The Reynolds number is expressed as follows:

$$R = \frac{Q}{d\frac{z}{s}}$$

In which:
Q = bbl. per hr.
d = diameter of pipe, in.
$\frac{z}{s}$ = kinematic viscosity in centistokes at mean flowing temperature.

This expression can easily be deduced from the fourth formula for R on the Pigott graph. $R = \frac{35.5\,Br,}{dz}$ by substituting for "r," weight of liquid per cubic foot, its equivalent of "62.5 × s," in which 62.5 is the weight of a cubic foot of water at 60°F., and s the specific gravity of the oil at the flowing temperature. The value of the equation will not be changed if s is moved from its position in the dividend to that of a divisor of z.

$$R = \frac{35.5 \times 62.5 \times B}{d\frac{z}{s}}$$

In which:
B = bbl. per hr.
d = diameter of pipe, in.
$\frac{z}{s}$ = kinematic viscosity in centistokes.

The only difference between this equation and that used on the graph is the presence of the constant 35.5 × 62.5. Why not eliminate the necessity for manipulating this constant in every calculation? This was done by plotting the "f" values pertaining to the R values with the constant against the respective R values without the constant. In this simple R equation the effect of a change in the flow rate, in the diameter, or in the viscosity can easily be visualized and calculated.

The pipe line will be in streamline flow for an R value of 0.54 and less, when the viscosity is expressed in centipoises. If poises are preferred, the value will be 54. All other R values will then become 100 times as great as used in this graph. All R values higher than 1.13 definitely indicate turbulent flow. These two values of R are called the lower and upper critical flow limits. For R values between these limits, the flow might be either streamline or turbulent. Further discussion of the "f" factor to use will follow later.

Returning to a previous statement:

(*Continued on Page 131*)

**Prof. Osborne Reynolds, "An Experimental Investigation of the Circumstances Whether the Motion of Water Shall Be Direct (Viscous or Streamline) or Sinuous (Turbulent) Philosophical Transactions" (1883).

(Continued from Page 122)

The formula given for a pipe line in streamline flow must be used only after it has been determined by means of the Reynolds number that the flow will be streamline.

Turbulent flow. If the Reynolds number pertaining to the flow rate, diameter, and viscosity under consideration indicates turbulent flow, the pressure drop can be calculated by the equation given on the curve, namely:

$$P = \frac{f\,s\,Q^2}{d^5}$$

In which:

f = friction factor, dimensionless.
s = specific gravity of oil at mean flowing temperature.
Q = bbl. per hr.
d = diameter of pipe, in.
P = pressure drop per 1000 ft., lb. per sq. in.

This again is a simple formula. It can easily be deduced from the Fourth Formula for P for turbulent flow on the Pigott graph.

$$dP = \frac{0.000106\,frLB^2}{d^5}$$

By substituting 1000 for L, and 62.5 Xs for r, the formula becomes:

$$\frac{6.63\,fsB^2}{d^5}$$

In the graph all "f" values were multiplied by 6.63 before plotting them, thus simplifying the labor of the calculating engineer.

It is here again suggested that the engineer either calculate the pressure drop in a pipe line of given length for a given quantity of oil and magnitude of specific gravity and viscosity by means of all the equations mentioned on the Pigott graph or that he convert the factors in the equations reducing all to the one he will choose as a tool. Thus only can he convince himself of the uniformity of the results to be obtained by the different equations. The basic equations of flow and the relationship between the Reynolds number and the friction factor must be taken on faith in the work of scientific investigators until by chance the reader can make observations of his own on operating pipe lines. Many observations are necessary to amend a well established empirical formula.

Effect of factor variations. The reader's attention was previously called to the fact that in streamline flow:

1. The pressure drop varies proportionately to the flow rate and to the absolute viscosity, and inversely as the fourth power of the diameter.
2. For the same pressure drop, the flow rate varies inversely as the absolute viscosity and proportionately to the fourth power of the diameter.

Not so for turbulent flow, in which the pressure drop varies proportionately to the second power of the flow rate times the ratio of the friction factors pertaining to the Reynolds number for the two flow rates. The value of the ratio of the friction factors varies with the position of the factors on the curve. If the flow

Approved as American standard by the American Standards Association, ASA No. Z11.46-1941. American Petroleum Institute Standard, A.P.I. No. 534-39.

STANDARD METHOD FOR CONVERSION OF KINEMATIC VISCOSITY TO SAYBOLT UNIVERSAL VISCOSITY[1]

A.S.T.M. Designation: D 446-39. Adopted 1939[2]

This Standard of the American Society for Testing Materials is issued under the fixed designation D 446; the final number indicates the year of original adoption as standard or, in the case of revision, the year of last revision.

Scope

1. The conversion table and equation included in this method provide a means for converting kinematic viscosity in centistokes at any temperature to Saybolt universal viscosity in seconds at the same temperature.[3]

Description

2. The Saybolt universal viscosity equivalent to a given kinematic viscosity[4] varies with the temperature at which the determination is made. The basic conversion values are those given in Table 1 for 100°F. The Saybolt universal viscosity equivalent to a given kinematic viscosity at any temperature may be calculated as described in Section 3. Equivalent values at temperatures of 130 and 210°F. are given in Table 1 for convenience.[5]

Procedure

3. For conversions at 100, 130, and 210°F., the equivalent Saybolt universal viscosity values may be read directly from Table 1. For kinematic viscosities between 2 and 70 centistokes that are not listed in Table 1, the equivalent Saybolt universal viscosity values may be obtained by linear interpolation. For kinematic viscosities over 70 centistokes, the Saybolt universal viscosity equivalent may be calculated by use of the multiplication constant given in Table 1 corresponding to the proper temperature. The Saybolt universal viscosity equivalent to a kinematic viscosity determined at t°F. may be calculated by multiplying the equivalent Saybolt universal viscosity at 100°F. by $1 + (t - 100)\ 0.000064$.

Supplementary Conversion Equivalents

4. The following equivalents are frequently used in connection with viscosity conversions:

Poise = c.g.s. unit of absolute viscosity
Centipoise = 0.01 poise
Stoke = c.g.s. unit of kinematic viscosity
Centistoke = 0.01 stoke
Centipoises = centistokes × density (at temperature under consideration)
Reyn (1 lb.-sec. per sq. in.) = 69 × 10^5 centipoises

TABLE 1

Values for converting kinematic viscosity to Saybolt universal viscosity.

Kinematic viscosity, centistokes	Equivalent Saybolt universal viscosity, sec.			Kinematic viscosity, centistokes	Equivalent Saybolt universal viscosity, sec.		
	At 100 °F. (basic values, see note)	At 130 °F.	At 210 °F.		At 100 °F. (basic values, see note)	At 130 °F.	At 210 °F.
2	32.6	32.7	32.8	31	145.3	145.6	146.3
2.5	34.4	34.5	34.6	32	149.7	150.0	150.7
3	36.0	36.1	36.3	33	154.2	154.5	155.3
3.5	37.6	37.7	37.9	34	158.7	159.0	159.8
4	39.1	39.2	39.4	35	163.2	163.5	164.3
4.5	40.7	40.8	41.0				
5	42.3	42.4	42.6				
6	45.5	45.6	45.8	36	167.7	168.0	168.9
7	48.7	48.8	49.0	37	172.2	172.5	173.4
8	52.0	52.1	52.4	38	176.7	177.0	177.9
9	55.4	55.5	55.8	39	181.2	181.5	182.5
10	58.8	58.9	59.2	40	185.7	186.1	187.0
11	62.3	62.4	62.7	41	190.2	190.6	191.5
12	65.9	66.0	66.4	42	194.7	195.1	196.1
13	69.6	69.7	70.1	43	199.2	199.6	200.6
14	73.4	73.5	73.9	44	203.8	204.2	205.2
15	77.2	77.3	77.7	45	208.4	208.8	209.9
16	81.1	81.3	81.7	46	213.0	213.4	214.5
17	85.1	85.3	85.7	47	217.6	218.0	219.1
18	89.2	89.4	89.8	48	222.2	222.6	223.8
19	93.3	93.5	94.0	49	226.8	227.2	228.4
20	97.5	97.7	98.2	50	231.4	231.8	233.0
21	101.7	101.9	102.4	55	254.4	254.9	256.2
22	106.0	106.2	106.7	60	277.4	277.9	279.3
23	110.3	110.5	111.1	65	300.4	301.0	302.5
24	114.6	114.8	115.4	70	323.4	324.0	325.7
25	118.9	119.1	119.7				
26	123.3	123.5	124.2	Over 70	Saybolt seconds = centistokes × 4.620	Saybolt seconds = centistokes × 4.629	Saybolt seconds = centistokes × 4.652
27	127.7	127.9	128.6				
28	132.1	132.4	133.0				
29	136.5	136.8	137.5				
30	140.9	141.2	141.9				

NOTE—To obtain the Saybolt universal viscosity equivalent to a kinematic viscosity determined at t°F. multiply the equivalent Saybolt universal viscosity at 100°F. by $1 + (t - 100)\ 0.000064$; for example, 10 centistokes at 210° F. are equivalent to 58.8 × 1.0070 or 59.2 Saybolt universal seconds at 210°F.

[1] Under the standardization procedure of the Society, this method is under the jurisdiction of the A.S.T.M. Committee D-2 on Petroleum Products and Lubricants.

[2] Prior to adoption as standard, this method was published as tentative from 1937 to 1939.

[3] See paper by C. E. Headington and J. C. Genlesse, "Method for Converting Kinematic Viscosity to Saybolt Universal Viscosity," *Proceedings*, American Society Testing Materials, Vol. 37, Part I, p. 380 (1937).

[4] The test procedure for determining kinematic viscosity is described in the Tentative Method of Test for Kinematic Viscosity (A.S.T.M. Designation: D 445) and the test procedure for Saybolt Universal Viscosity appears in the Standard Method of Test for Viscosity by means of the Saybolt Viscosimeter (A.S.T.M. Designation: D 88), see pp. 338 and 347.

[5] In order to avoid unnecessary interpolations, tables based on this method may be employed. A.S.T.M. Conversion Tables for Kinematic and Saybolt Viscosities are published separately and copies at 25 cents each may be obtained from Society headquarters, 260 South Broad Street, Philadelphia 2, Pennsylvania.

rate is doubled, that is, increased from one to two, a mean value of the ratio of the friction factors is about 0.85. The pressure drop for double the flow rate, therefore, will increase as $\frac{2^2}{1^2} \times 0.85$ or 3.4 times, for the same length and diameter of pipe. In streamline flow, the pressure drop would have only doubled for twice the flow rate.

The effect of a change in viscosity is less marked in turbulent flow. For the same pressure drop, the ratio of capacities of a pipe line for a viscosity reduction of 50 per cent will be approximately equal to the square root of the inverse ratio of the friction factors pertaining to the two viscosity values:

$$\frac{Q_2}{Q_1} = \sqrt{\frac{f_1}{f_2}} = \sqrt{1.19} = 1.09 \text{ (average)}$$

So drastic a reduction in viscosity as 50 per cent will, therefore, give the pipe line an increase in capacity of only about 10 per cent, neglecting the small effect of a probable reduction in the specific gravity. In a pipe line in streamline flow, the capacity would be doubled.

For an increase in pipe diameter for the same flow rate and viscosity, the pressure drop will decrease in proportion to the inverse ratio of the fifth powers of the diameters multiplied by the ratio of the friction factors pertaining to the diameters. If d_2 is larger than d_1, then:

$$P_2 = P_1 \times \frac{d_1^5}{d_2^5} \times \frac{f_2}{f_1}$$

The ratio of the friction factors again depends on the position on the curve of the Reynolds number pertaining to the given factors. For an increase in size of pipe diameter from 8 in. to 10 in. an average value of this ratio is 1.07. Then:

$$P_2 = P_1 \times \frac{8^5}{10^5} \times 1.07 = 0.35 \times P_1$$

The effect of a variation in the magnitude of the various factors of the flow formulas is dwelled upon in detail for two reasons, one, theoretical, and the other, practical.

The engineer will not understand the theory of any formula and all the formula's possibilities unless he has made himself thoroughly aware of the effect of magnitude variations in the various factors.

Knowing the effect of such variations, the engineer will be able quickly to estimate the change in the calculated result of a given problem through factor magnitude variations. He will find that knowledge valuable.

In all flow calculations, not the nominal pipe diameter but the actual interior diameter of the pipe should be used. In days past, only standard and extra heavy pipe were available and most tabulations of the fourth and fifth powers of diameters give the values for these two weights of pipe. In recent years pipe of thinner wall than that of standard thickness has been used, particularly in the sections of a line with reduced pressure. A reduction in wall thickness increases the internal diameter, for pipe is rolled to the same external diameter no matter what the thickness of metal. Appreciable reductions in pressure drop are the consequence of thinner pipe walls. Later some remarks will be made concerning the accuracy that can be expected of flow calculations.

Refinery lines. In some refineries the velocity of flow in the interconnecting pipe lines is more or less arbitrarily limited to certain values, 5 to 7 ft. per sec. for pumping lines, for instance, and 2 to 4 ft. per sec. for suction lines to pumps. The following formula will indicate the required pipe size for the given flow rate and limiting velocity:

$$d = \sqrt{\frac{0.286 \times Q}{v}}$$

In which:

d = diameter of pipe, in.
Q = bbl. per hr.
v = velocity, ft. per sec.

The diameter of the nearest commercial pipe size can then be taken for use in the flow formulas to determine the pressure drop.

Friction factor for streamline flow. It will be noted that in the streamline region only one curve is shown on either of the two graphs, (Graphs 1 and 2,) whereas in the turbulent region a number of curves are drawn. The reason for this difference lies largely in the fact, determined by test and theoretical analysis, that the roughness encountered in ordinary commercial pipes of various materials and manner of manufacture has little effect upon the friction factor in the streamline flow region, whereas its effect in the turbulent flow region is appreciable. The non-effect of roughness on streamline flow can be explained by examples. A liquid of low viscosity can be in streamline flow only at exceedingly low velocities. Water, for instance, must flow in an 8-in. pipe at a velocity of 0.04 ft. per sec. or at the rate of 8 bbl. per hr. At so low a velocity ordinarily encountered roughness will not affect the friction loss. Viscous oil, even when flowing at a higher velocity, forms a stationary film on the pipe wall, so long as it is in streamline flow. The film is very likely of greater thickness than the depth of the pipe metal protruding inward beyond the mean surface of the pipe, the film covering the roughness.

Friction factor for turbulent flow. The Pigott graph (Graph 1) gives for the turbulent flow region the friction factors for commonly used pipe of various materials of construction. Graph 2 limits itself to steel pipe as used for the transportation of oils only. Curves for pipes of other materials, such as concrete, brick, wood, etc., are available in many different publications. These pipes are used largely for the conveyance of water. On both graphs the curves for the larger size pipes lie lower than those for smaller size pipes, resulting in lower friction factors for the same Reynolds numbers. This is due to the relatively greater roughness in smaller pipes, the protuberances into the mean diameter having been carefully measured and found to be approximately the same in depth for the pipes of a given material and irrespective of the measure of the diameter. Pigott's article, from which both graphs were taken, gives a more detailed review of the effect of roughness than can be included in this article. The relative roughness is indicated, however, on the Pigott graph.

Friction factor for unsteady flow. Both graphs show an overlapping of the friction factors for streamline and turbulent flow between the lower and upper critical flow limits, indicating that the flow may be either streamline or turbulent. It is generally held that in both cases the kind of flow previously existing tends to persist. When oil cools in a flowing line, for instance, the increasing viscosity will decrease the Reynolds number below the upper critical value. Turbulent flow, however, might persist until or almost until the lower critical value is reached. When oil is heated in a flowing line, on the other hand, streamline flow might persist until the Reynolds number approaches the upper critical value. The flow in this region is apt to be unsteady and many investigators and compilers, including Pigott, recommend the use of the turbulent values for f in this region as the only safe procedure.

Beal and Docksey, however, in an article in the *Journal Inst. Petr. Tech.*, August, 1932, report a series of tests with water showing that the transition from turbulent to streamline flow, or vice versa, takes place along an S shaped curve indicated on both graphs. Others have shown the existence of the S transition by careful mathematical analysis. In two tests on flowing oil lines the writer found the S transition, but not in a third test. Additional investigations are needed to clarify this phenomenon.

What difference in the calculated total pressure will result from the use of the turbulent f curve rather than of the streamline curve? In a long pipe line handling a light oil in isothermal flow an increase in the calculated pressure of as much as 25 per cent may result, if the Reynolds number falls just to the left of the upper critical value. This condition of flow will very seldom exist, for light oil lines of economic size are decidedly in turbulent flow. In long, heavy oil lines, however, this unsteady flow is likely to occur for a few miles as the oil cools, the flow changing from turbulent to streamline. Such lines usually pump at a pressure of from 800 to 1000 lb. per sq. in. It will be shown later that the calculated overall pumping pressure will increase by not more than a few per cent by using the turbulent f factor in this region. Pipes in oil heaters in which the flow changes from streamline to turbulent are usually short, the transition region still shorter, and the use of the turbulent f factor is recommended for the sake of safety. ★★★

(This article by Mr. Karge will be continued in an early issue.)

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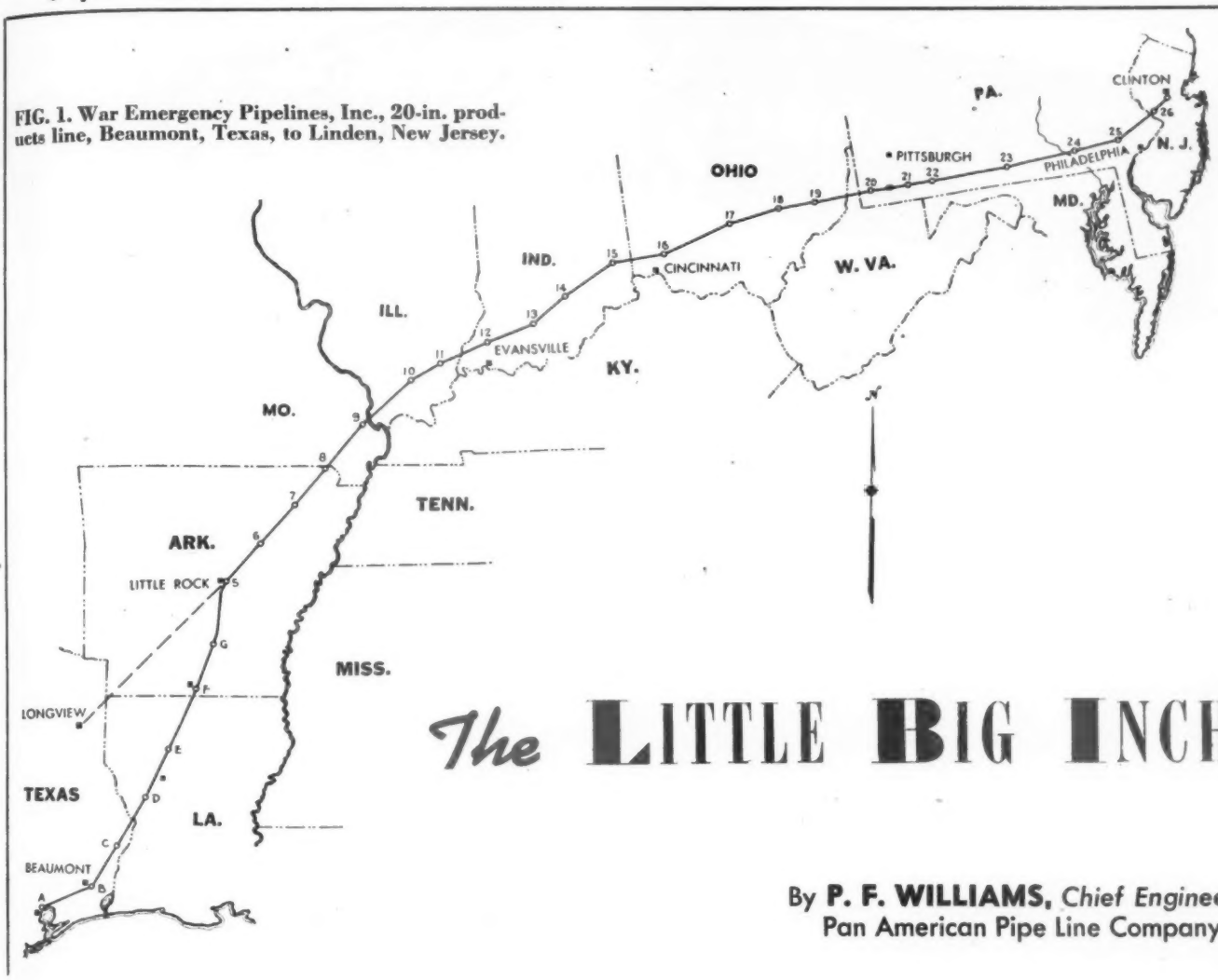


FIG. 1. War Emergency Pipelines, Inc., 20-in. products line, Beaumont, Texas, to Linden, New Jersey.

The LITTLE BIG INCH

By **P. F. WILLIAMS,** *Chief Engineer*
Pan American Pipe Line Company*

EXCLUSIVE THE general problem confronting the Engineering Department of War Emergency Pipelines, Inc., in the designing of the 20-in. products pipe line, which traverses 1475 miles from Beaumont, Texas, to the Bayway area on the east coast, was that of transporting four different refined petroleum products at the rate of 235,000 bbl. per day with the least possible contamination.

These four products, whether they be different grades of gasoline, kerosine, or heating oil, are handled in separate tenders or batches.

Beginning at Beaumont, Texas, the 20-in. line was laid in a northeasterly direction to Little Rock, Arkansas, from which point to the east coast it parallels the 24-in. crude oil line from Longview, Texas, on the same right-of-way. The accompanying sketch shows its approximate location traversing 9 states to the eastern terminal at Linden, New Jersey.

The first problem was to receive products from the different refineries in the Gulf Coast area around Texas City, Baytown, Port Arthur, Lake Charles, and Beaumont. This entire area is considered the feeder system to the main line, which begins at Beaumont, Texas.

The Baytown station is the first receiving station and the terminus of deliveries from 6 refineries in that area. Fifty-eight miles of 8-in. and 10-in. lines comprise this gathering system.

A tank farm consisting of twelve 80,000 bbl. tanks has been so constructed, and tank lines so laid, that any one of the four products may be handled in its own separate line or tank. This was done by laying 4 filling lines in the tank farm, each cross manifolded so that any tank could be used for any product.

Contamination in handling different refined petroleum products was a big problem in designing 20-inch pipe line.

Four suction lines were laid and these also are cross manifolded in order that suction can be taken from any tank into its own product line.

A double-suction, single-stage centrifugal pump having a head of 130 ft. and a capacity of 150,000 bbl. a day, has been provided in the tank farm to deliver into the suction of the main pump station where three single-stage centrifugal pumps in series discharge through a 16-in. line to Beaumont, 62 miles to the east of Baytown.

The Beaumont tank farm and receiving terminal is very similar in design to the one at Baytown, but consists of twenty 80,000 bbl. tanks.

In addition to the 16-in. line into Beaumont from Baytown, six lines, 6, 8, and 12 in., have been laid to receive products from refineries in the Beaumont, Port Arthur, and Lake Charles areas.

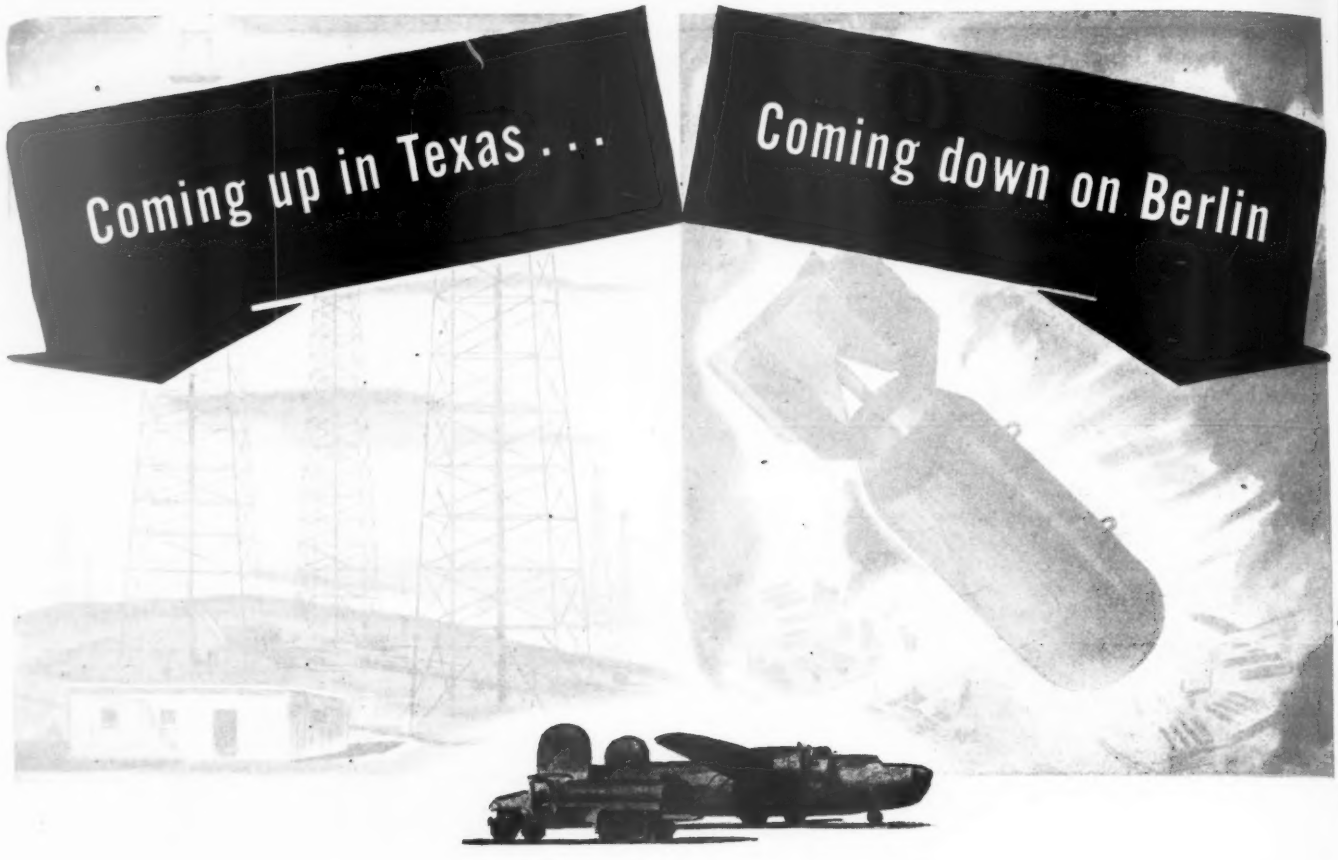
Two double-suction centrifugal pumps have been installed at the Beaumont tank farm to deliver products into the suction of the first main line pumping unit, which is situated at the edge of the farm.

Twenty-eight such pump stations are necessary between Beaumont and Linden to maintain capacity flow.

Considerable study was given to location of the pump stations on the properties in order to take advantage of the contours to obtain good drainage to the sump tanks and slop tanks from the station proper.

The line drawing of a typical three-

*Williams was loaned by Gulf Oil Corporation to War Emergency Pipelines, Inc., for construction of both 24-in. and 20-in. pipe lines. Subsequently joined Pan American.



. . . WITH THE AID OF WORTHINGTON PUMPS

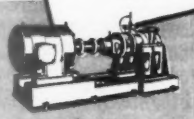
Oil that comes up in Texas makes it possible for bombardiers to drop destruction squarely on Berlin. And all along the line—from petroleum field . . . to refinery . . . to tank farms or shipping terminal . . . to bombers — many types of Worthington Centrifugal Pumps are on the job.

And speaking of diversity, Worthington offers the *broadest* line of centrifugal pumps for petroleum industries . . . the only *complete* line of chemical pumps for the corrosive services . . . and the world's greatest wealth of pump application "know-how".

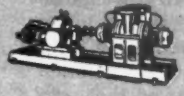
On the basis of the experience gained in solving past and present pump engineering and application problems, Worthington is better prepared to provide the pump engineering required for the new processes ahead. Get in touch with our nearest District Office. *Worthington Pump and Machinery Corporation, Centrifugal Pump Division, Harrison, New Jersey.*

THE WORLD'S LARGEST MANUFACTURER OF PUMPS

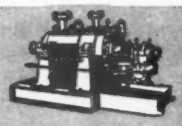
WORTHINGTON BEHIND THE NAME WORTHINGTON



Types HR and HB. Twenty sizes. Capacities up to 1800 g.p.m. Developed heads up to 900 ft. Proper selection of material permits use for temperatures far below zero to 800°F., for pressures from high vacuum to 750 lb. per sq. in. gauge.



Type HD. Hydraulically-balanced, double-suction impeller handles boiling liquids with low submergence. Capacities range from 600 to 3200 g.p.m. at heads up to 700 ft., temperatures up to 850°F., pressures up to 550 lb.



Type WH. High-pressure, high-temperature, centrifugal hot-charge pumps. Twelve distinct points of superiority based on years of experience building pumps for high pressures and temperatures. Capacities to 2000 g.p.m., heads to 5000 ft.

Type HL. Several construction arrangements permit flexibility in application. Designed for temperatures up to 225°F., or higher with water-jacketed stuffing box. Capacities up to 1600 g.p.m., heads to 500 ft.

unit pump station, shown herewith (Fig. 4) illustrates the relative position of the manifold piping, sump tanks, filters, pump house, and main line. This shows the care taken in the design of the piping to minimize contamination from dead pockets.

Products entering each pump station from the 20-in. main line flow through five horizontal "hay tanks" filled with excelsior for removal of sediment before it reaches the pumps. These filtering units are mounted over a concrete platform convenient for periodic replacement of the excelsior.

Each station and each individual pump is provided with a bypass fitted with suitable check valves.

The suction and discharge valves on each side of each pump are quarter turn, plug type, and are motor operated.

The station throttle valve, which is air actuated, regulates station discharge pressure and also prevents the suction pressure from falling below 30 lb. Pressure switches shut down motors progressively, if pump case pressure rises to 1000 lb., or line pressure is excessive, i.e., in the range of 850 to 1000 lb. Thermostatic switches also shut down motors if critical temperatures become excessive.

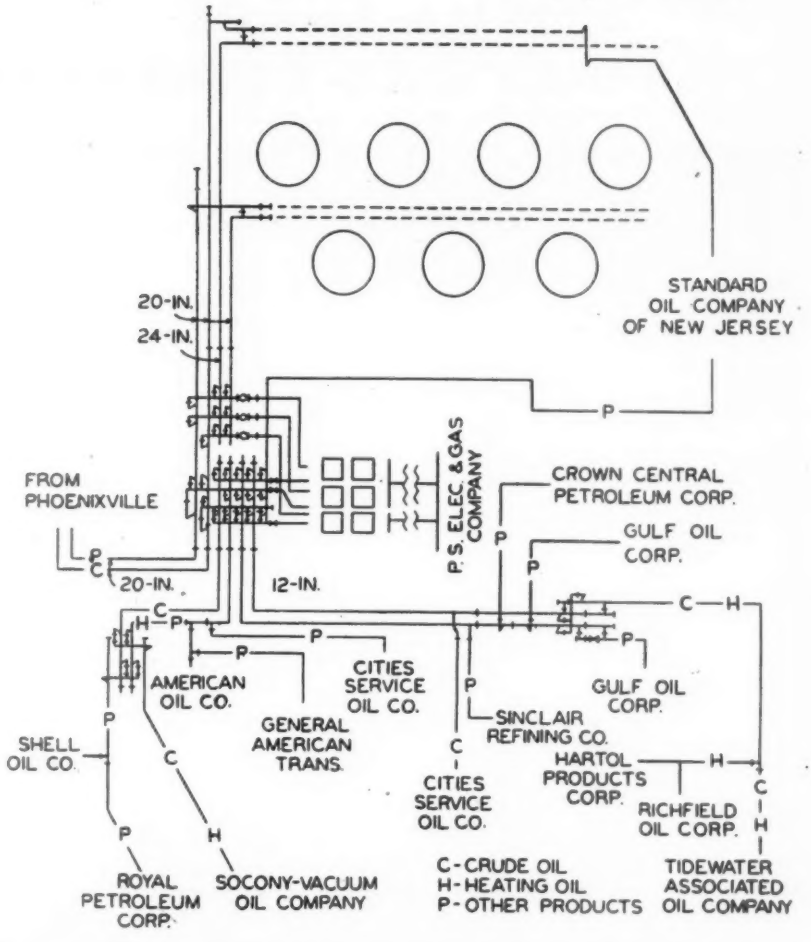
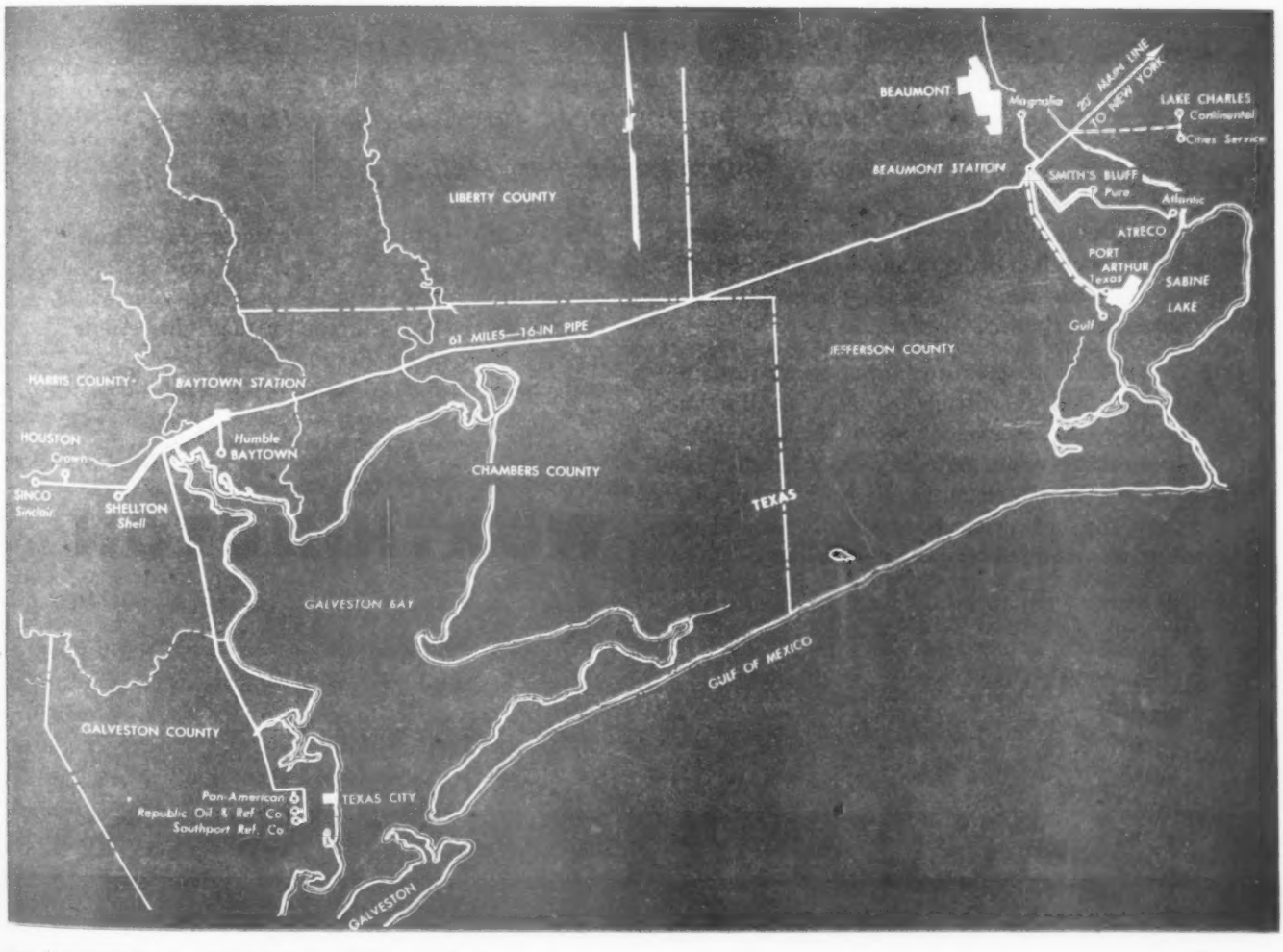
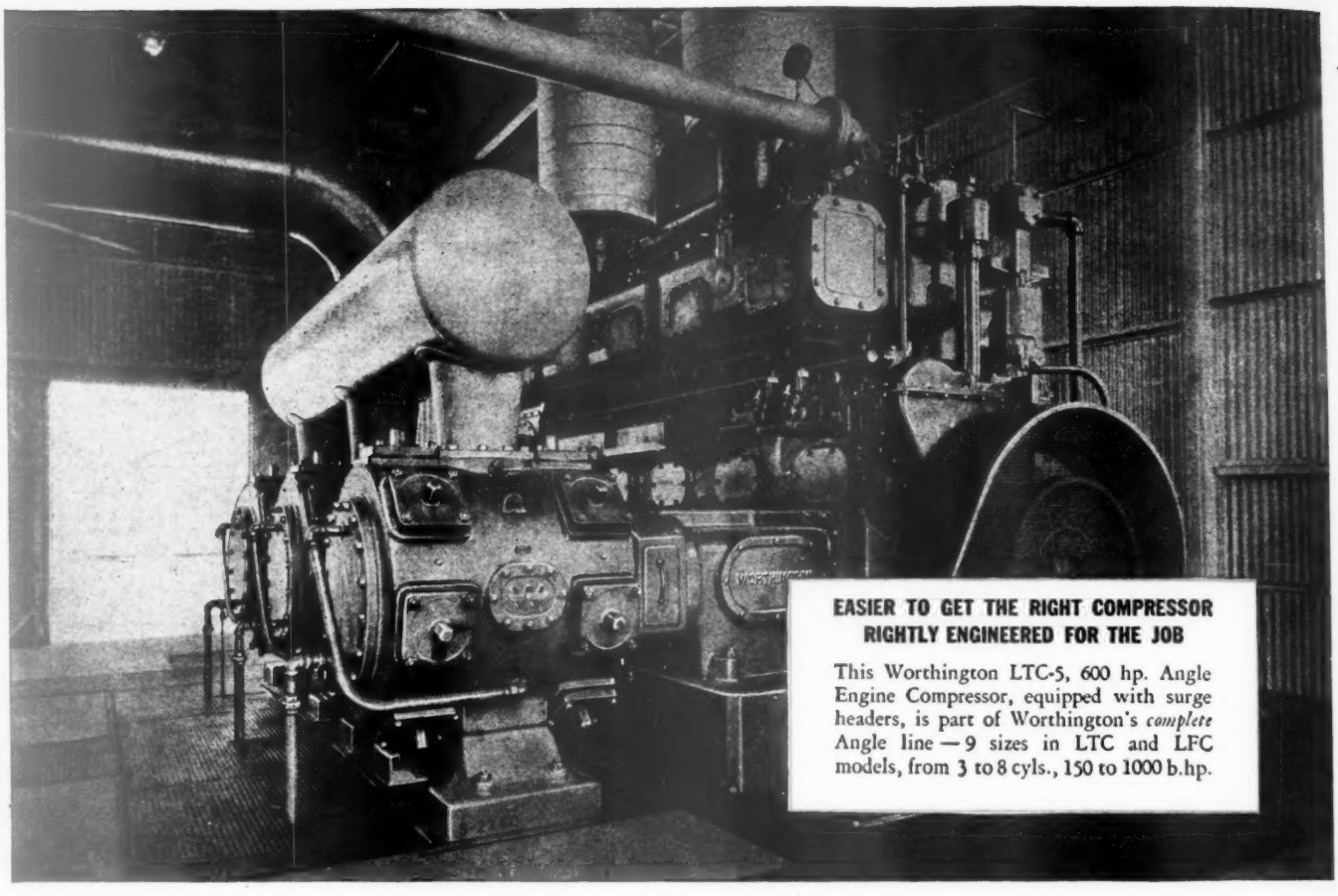


FIG. 2. *Right*—Schematic diagram of distribution area.

FIG. 3. *Below*—Baytown-Beaumont feeder system.



WILL SURGE HEADERS CUT YOUR GAS COMPRESSION COSTS?



EASIER TO GET THE RIGHT COMPRESSOR RIGHTLY ENGINEERED FOR THE JOB

This Worthington LTC-5, 600 hp. Angle Engine Compressor, equipped with surge headers, is part of Worthington's *complete* Angle line — 9 sizes in LTC and LFC models, from 3 to 8 cyls., 150 to 1000 b.hp.

. . . ask a Worthington Engineer for help on getting more Compression per Dollar

Often substantial savings result when the pulsation, or surge, of each cylinder of an Angle Engine Compressor is *smoothed out* by installing large headers to receive each cylinder's discharge.

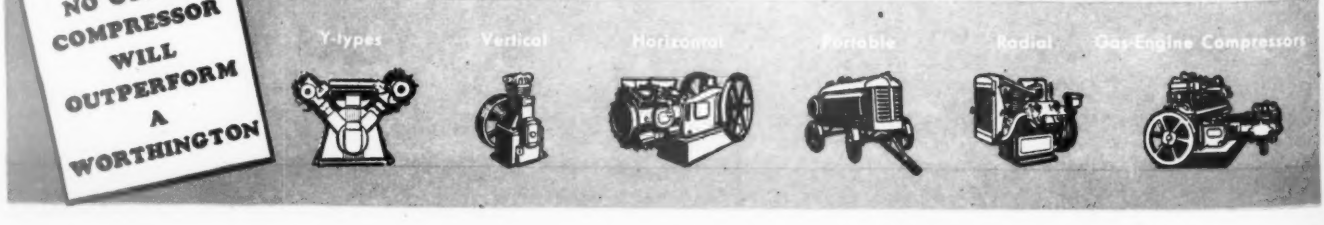
Surges are thus prevented from going into the discharge line, permitting use of a smaller line figured on a uniform velocity basis. Reduced vibration minimizes wear, reduces stresses in materials and avoids risk of damaged equipment. In a number of cases, the surge drums have actually reduced the horsepower required for gas compression.

Whether or not to install surge headers is only one of many questions a Worthington Gas Engineer can help you solve . . . to get the most for your compression dollar. He makes it worth your while to come *first* to Worthington for the right "Angle" for you. *Worthington Pump and Machinery Corporation, Buffalo Compressor Division, Buffalo, New York.*

WORTH BEHIND THE NAME WORTHINGTON

GC4-10

NO OTHER COMPRESSOR WILL OUTPERFORM A WORTHINGTON



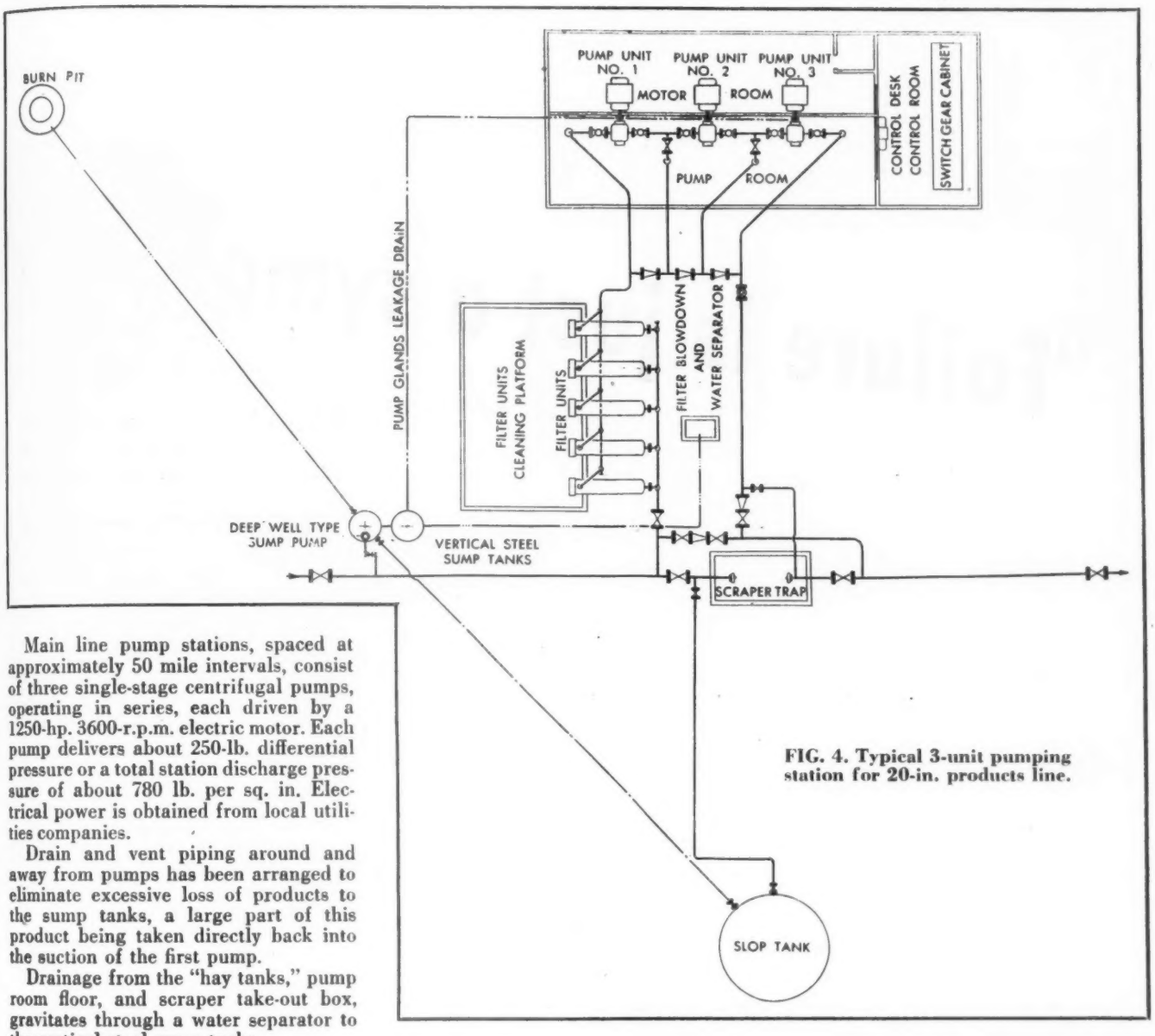


FIG. 4. Typical 3-unit pumping station for 20-in. products line.

Main line pump stations, spaced at approximately 50 mile intervals, consist of three single-stage centrifugal pumps, operating in series, each driven by a 1250-hp. 3600-r.p.m. electric motor. Each pump delivers about 250-lb. differential pressure or a total station discharge pressure of about 780 lb. per sq. in. Electrical power is obtained from local utilities companies.

Drain and vent piping around and away from pumps has been arranged to eliminate excessive loss of products to the sump tanks, a large part of this product being taken directly back into the suction of the first pump.

Drainage from the "hay tanks," pump room floor, and scraper take-out box, gravitates through a water separator to the vertical steel sump tanks.

Products are pumped from the sump tanks by a vertical type sump pump back into the main line, or to the burn pit.

Each main line pumping unit is operated by a single "start-stop" push button installation that automatically opens the suction valve, starts the motor, and opens the discharge valve in proper sequence. An electric control desk indicates to the operator which pumps are operating, the position of valves, the flow of oil, and the cause of any shutdown.

Because of the war-time steel shortage, pump houses were constructed of wooden framing, covered with 5/8-in. fiber board. The inside of the building is covered with 1/8-in. transite, the outside with 1/4-in. transite. Roofs have asbestos shingles. The pump and motor room are separated by a firewall with a continuous glass sash at eye level. The control room is separated from both pump room and motor room by a firewall with plate glass windows for viewing both pump and motor rooms.

A teletype, telephone, and Morse code system provide a means of communication between all stations and the dispatcher.

The eastern terminal of the line is near Linden, New Jersey, which is easily accessible to the oil companies' tank farms and loading docks in the entire Bayway area. Two 12-in. lines were laid for distribution of products to these existing facilities.

The pump station consists of one double-suction single-stage centrifugal pump having a 125 ft. head and two single-stage centrifugal pumps delivering 250-lb. differential pressure for increasing pressures through these delivery lines and is housed in the same building used by the 24-in. crude oil line. Seven 80,000 bbl. tanks are used not as storage facilities, but for floating on the line, the products being moved direct to facilities that can handle to the best possible advantage the petroleum products that are being transported through the line.

The "Little Big Inch" provides "express service" of products from the Gulf Coast to the Atlantic Seaboard with no intermediate gathering or distributing branch lines throughout its entire length.

★ ★ ★

File application to build line

The American Light and Traction Company has filed application with the Federal Power Commission for permission to build 1085 miles of natural gas pipe line from near Guymon, Oklahoma, to Detroit, Michigan, and Toledo, Ohio. The line will be of 22-in. and 26-in. diam. and will cost approximately $51,500,000, company officials said. If permission for the line is granted, the company expects to begin actual construction by May 1, with completion scheduled for the end of the year.

then he said to himself

"Failure is just a symptom"

David Lloyd George, the man who *turned the tide* of World War I, gives to postwar planners the secret behind that turn.

In his "War Memoirs" he writes that when the war was handed to him at the end of 1916 the fortunes of the Allies were at their lowest ebb.

That is history . . . but what he found to be *the cause* and *the cure* is as fresh as though written to guide the strategy of today's business planners. Says he:

> "Two failures on key questions had completely transformed the military position to our disadvantage. The first was the failure to realize that this was a war of machinery . . . and we had neglected to *improve* the Allied equipment."

This proves he is a good business man to make that discovery . . . and a better man to ACT before it is too late.

Neglecting to improve equipment, and production, and cost is the surest road to the valley of any business curve.

. . . But for climbing out, and up . . .

FIG. 1. Applying bell-hole welds on 20-in. tie-in line to the Big Inch near Phoenixville, Pennsylvania.

FIG. 2. Welding a section of the 24-in. pipe line on the Tennessee Gas and Transmission project in Louisiana.

NATION'S WELDED PIPE LINE CONSTRUCTION DURING WAR YEARS TOTALS OVER 18,000 MILES

By **C. M. TAYLOR,** *Vice President,* The Lincoln Electric Company

EXCLUSIVE EVIDENCE of widespread acceptance of arc welding as standard practice for pipe line construction is conclusively shown by recently compiled figures, which reveal that arc welded pipe line construction during the last 3 wartime years in this country totals over 18,000 miles, or an average of 6061 miles per year.

These figures are particularly significant in view of tightened rail and water transportation facilities during the last several months. During 1944, for example, the movement of petroleum and its products through new pipe lines to the east coast alone exceeded the volume moved by rail and more than doubled the volume transported by tanker vessels to that area.

In analyzing reports of the year's pipe line activities received from leading contractors throughout the country, it is found that the trend to the stove-pipe method of welding continues. In some instances, however, roll welding methods are effectively employed over stretches of flat terrain.

In stove-pipe welding the plain end joint without liner is generally used with 0.040 in. to 0.065 in. spacing at the joint for most effective weld penetration. In instances of gas line welding, a liner is used in combination with the plain end joint and with a spacing of 1/8 in. to 3/16 in. at the joints.

One joint at a time is position welded to the line by stove-pipe methods, thus making it possible to use a minimum number of crewmen under one supervisor, and a minimum of equipment. After aligning and tack welding the joint, during which the pipe is usually held in place by a line-up clamp, two welders frequently work simultaneously, one on each side of the joint, applying the bead downhand from the top as shown in the construction views (Figs. 1 and 2).

Stove-piping, which was the highly preferred welding technique even before the use of larger diameter pipe came into prominence, is now being extensively used on the larger sized pipe up to 26 in. diam.

Stove-pipe method of welding continues as trend in construction of pipe lines—widely used on large sizes.

The method is also used extensively for gas lines, the plain end joint being fused together with a liner because this has been found most economical. Resistance to the flow of gas caused by the liner is negligible. Ordinarily, liners are 2 in. in width and two welding beads are required.

The recommended amperage and voltage for various sizes of electrode follows:

	Size rod	Amperage	Voltage
Position welding	1/8 in.	100-150	25-40
	5/32 in.	125-200	25-40
	3/16 in.	125-200	25-40
Roll welding	Size rod	Amperage	Voltage
	1/8 in.	100-150	30-40
	5/32 in.	125-200	30-40
	3/16 in.	150-225	30-40
	7/32 in.	175-300	30-40
	1/4 in.	200-325	30-40
	5/16 in.	250-400	30-40
	3/8 in.	350-500	30-40

The following excerpt, which deals with bell-hole or tie-in welding procedures, is taken from specifications generally followed by leading contractors and is a typical sample of prevailing specifications for arc welding oil or gas pipe lines:

▸ **Bell-hole or tie-in welding.** Three beads or more shall be used in making tie-in welds. Each bead shall be cleaned of all scale, slag, dirt, etc., prior to the application of each succeeding bead. The dimensions of the completed weld shall be the same as for rolling welds. The point of starting shall be acceptable to the field inspector. Tie-in welds are to be free from pin-holes, non-metallic inclusions, etc., and in case of defects, the inspector shall have the right to require more beads.

▸ **Weld characteristics.** The intent end purpose of these specifications is to make possible a 100 per cent weld as to strength, ductility, fusion, and penetra-

(Continued on Page 146)

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In every detail of construction, including the development of special bearing metals, the Ironcase meter gives you the benefit of cumulative experience in measurement engineering.

Ironcase meters are available in a complete range of sizes and pressures.

Shown above is the AMERICAN *500-B Ironcase equipped with our Base Pressure Index. The latter gives a totalized reading of the quantity of gas which passes through the meter in cubic feet (at the base pressure). Each cubic foot (at line pressure) is multiplied automatically by the factor for line pressure.*

It is equipped with a supplementary counter in the rear which gives a reading of the actual volume at line pressure. This is required when this index is used with a Volume and Pressure Gage, which gives a permanent chart record of rate of flow and pressure.

(Continued from Page 143)

tion for the entire circumference of the weld, including the points at which the tacks occur.

The tensile strength of the weld shall not be less than the minimum tensile strength guaranteed on the pipe. This minimum tensile strength shall be determined in the field with a portable tensile testing machine.

The ductility of penetration of the weld shall be such that coupons cut from the weld in the field will withstand a bend test of at least 90 deg. in either direction without fracture. The coupons used for bending shall have the reinforcement removed so that the coupon will have the same thickness throughout its entire length; also a notch shall be ground or cut into both edges of the weld so that the bend will be completely on the weld.

In conducting these bend tests, the specimens will be placed in a bending apparatus and bent around a pin of ½ in. diam. The peneration shall not be less than the original thickness of the pipe wall.

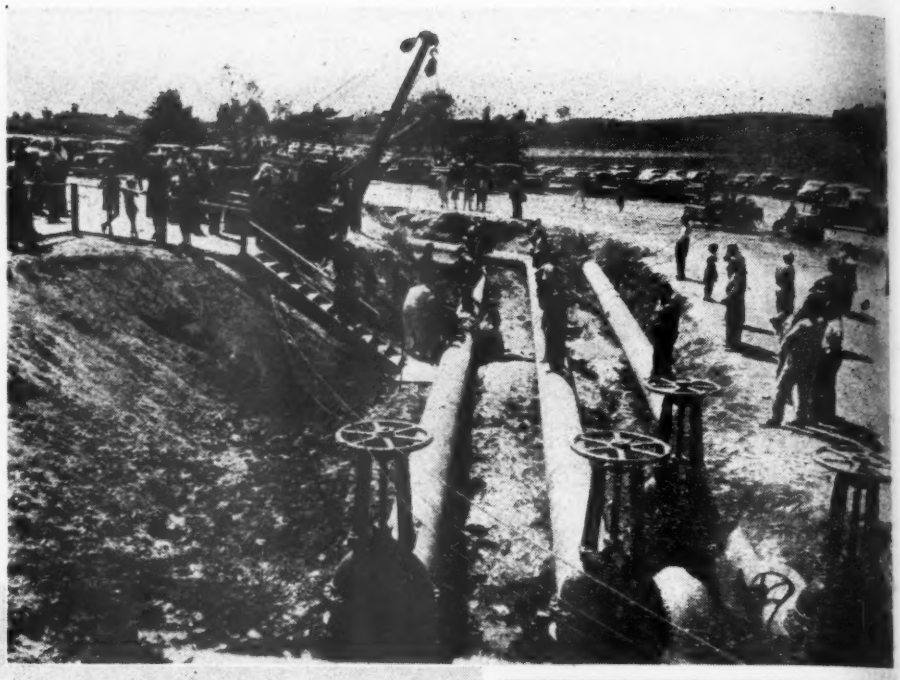

FIG. 3. *Right*—Valve sections being welded into the 20-in. pipe at a bend in the line.

FIG. 4. *Below*—Tractor lining up the Big Inch tie-in at site of bend.

FIG. 5. A complicated section of 20-in. pipe tie-ins for the extended lines.

▸ **Competent workmen.** The contractor shall use only competent and skilled workmen for welding and all work shall be completed in a workmanlike manner to the satisfaction of the inspector. Should any welder perform work that is not satisfactory to the inspector, such workman shall be immediately released by the contractor. Before being allowed to weld on the line, each welder is to pass a satisfactory welding test to assure the inspector that he is competent.

▸ **Testing and stenciling welds.** The inspector shall stencil each weld with the welder's number for the purposes of future identification. Girth welds shall be cut out of the line under the direction of the company's inspector from which coupons shall be cut for tensile or bending tests. As many coupons shall be cut from any weld as it is deemed necessary. The contractor shall cut out test welds at no expense to the company. The company agrees to pay for each weld so cut out on the basis of the contract price per weld. All welds found to be defective shall be cut free of any charge whatsoever to the company. The company reserves the right to select welds whenever the occasion demands for the purpose of testing.

▸ **Head welding.** Normally, five joints of pipe shall be welded into one continuous length or section. Welds so made shall be known as the rolling weld method.

▸ **General clauses.** The welding contractor is to provide a suitable number of dollies for welding the pipe, the normal length being in 5-joint sections. In case of windy weather suitable wind guards shall be provided to protect the work. Welding shall not be carried on when in

QUOTS

"Under the provisions of the Surplus Property Act of 1944 these (pipe lines built for emergency) lines may be leased for a term of not more than five years, but they cannot be sold without the approval of Congress. Consideration will be given . . . to the future need for these pipe lines for national defense and security reasons. The presently unpredictable course of future events . . . will exercise a great influence on their ultimate disposition. It may be anticipated, therefore, that much public discussion will be required before it can be determined how these lines are to be used in the future."—*Sam G. Spal, The Interstate Commerce Commission.*

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AUTHORITIES differ as to the major cause of cylinder wear. But all are in agreement that the cost of cylinder wear together with the expense of cylinder and ring replacements in industrial size Diesels, constitute the major expense item on the maintenance sheet. Assuredly many variables enter the picture, but there is one thing certain—if piston rings could be dispensed with, little wear would occur. It is apparent then, that the piston rings to use are rings specially engineered to minimize wear. COOK has specialized in this all important phase of piston ring development for over 20 years, with the result that COOK'S GRAPHITIC IRON Piston Rings come as near to being frictionless as rings can be. If you do not have the full story of COOK'S GRAPHITIC IRON, write for special bulletin, but better still—to reduce the rate of cylinder wear in your engine, on your next requisition, instruct your buyer to order COOK'S GRAPHITIC IRON Piston Rings. If you need help do not hesitate to call on COOK'S engineers.

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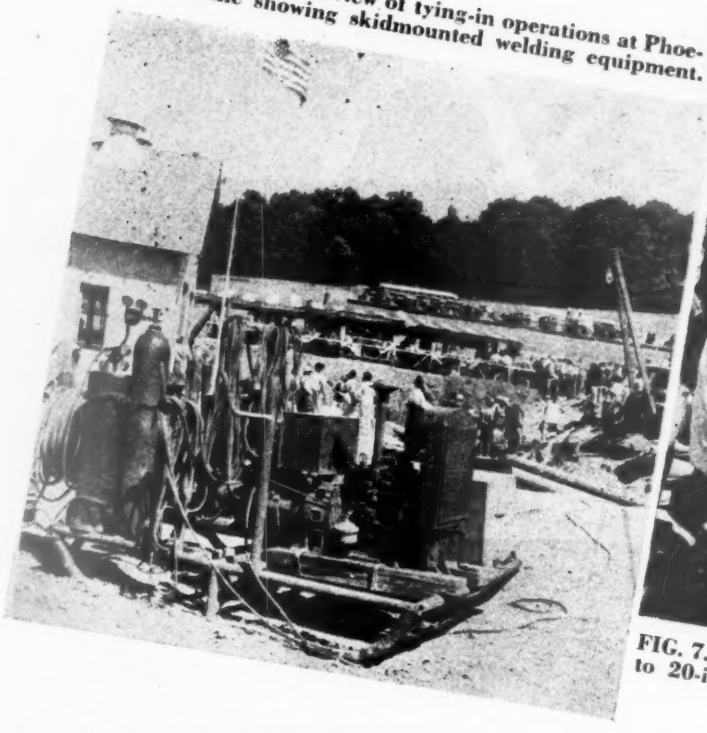
FIG. 6. General view of tying-in operations at Phoenixville showing skidmounted welding equipment.



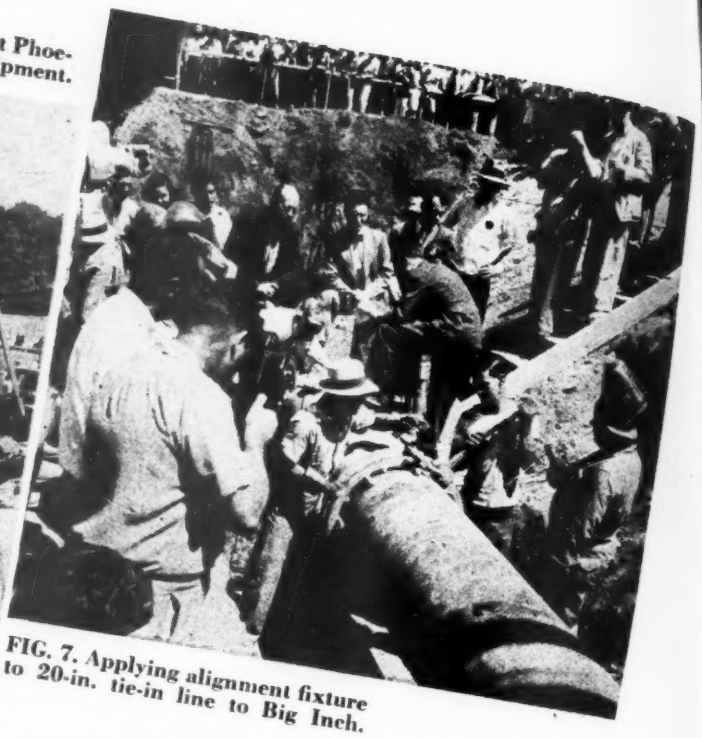


FIG. 7. Applying alignment fixture to 20-in. tie-in line to Big Inch.

the judgment of the company inspector the weather is unfit. If any pipe shall be burned during the welding, the burned portion shall be cut out and the joint rewelded, the expense of which, including pipe cut out, additional material used, etc., shall be borne by the contractor. All welding equipment shall be maintained in first-class condition and shall be subject to the approval or rejection of the company at all times. The use of mitred welds will not be permitted.

The pipe ends shall be beveled at an angle of not less than 30 deg. with the vertical making the included angle 60 deg. This angle will be subject to change, if necessary, to improve the welding.

Should laminations or split ends develop in the pipe during the process of welding, the full joints containing these said defects shall be removed from the line and they are not to be used later in the main line construction, and the removal of defective joints shall be done at no added expense to the company.

On the initial bead, the maximum size rod for the minimum spacing shall be used at all times.

▸ **Defective welds.** Welds cut out by the company's inspector as being defective quality or improperly made will not be paid for by the company.

▸ **Miscellaneous.** Various views of the tie-in operations of the "Big Inch" line at Phoenixville, Pennsylvania, are shown in Figs. 3 to 7, inclusive. This project involved the welding of two 20-in. lines tied into the 24-in. line. One 20-in. line extended from Phoenixville to Philadelphia and the other line to New York.

Typical of the oil pipe line jobs laid during the last year, but by no means the largest, was that for the Sun Pipe Line Company from the Seeligson pool in Jim Wells County, Texas, to Sullivan pool in Brooks County. This was an 8-in. line stretching over fairly flat prairie. Figs. 8 to 14, inclusive, show various views of the work on this project in which the most advanced welding technique and modern equipment were used.

In general, contractors have found that great efficiency is effected by using modern welding techniques and equipment for pipe line construction that have proved highly successful over the last few years of intense activity in the industry.

Photographs and much of the data given in this article were supplied by leading contractors, including Allied Welding and Engineering Company, H. C. Price Company, Ray L. Smith Construction Company, Bechtel, Dempsey, Price Pipe Line Construction Corporation, I. C. Little, Sharman and Allen, Midwestern Engineers, O. C. Whitaker Company, Jones and Brooks, Williams Brothers, Oklahoma Contracting Company, Sheehan Pipeline Construction, J. W. France and Company, Morrison Construction Company, C. S. Foreman, Eastern Construction Company, Pacific Pipeline Construction Company, N. A. Saigh and Company, Anderson Brothers, C. W

FIG. 8. Ditcher in operation on Texas pipeline project.

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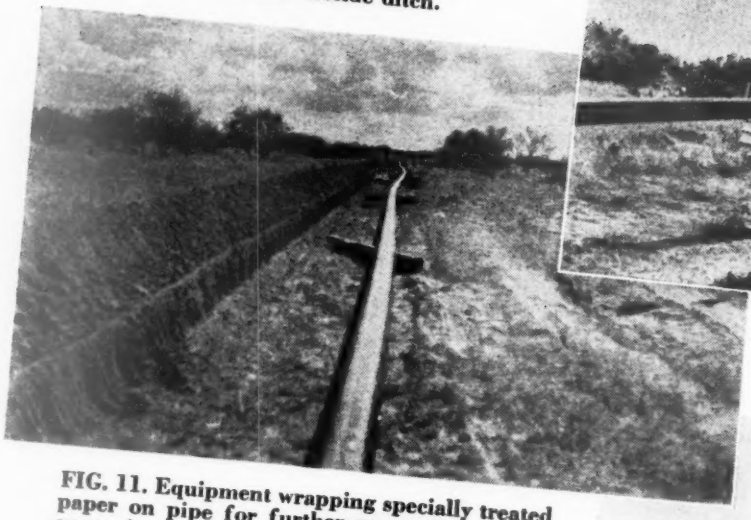
FIG. 9. General view of long stretch of welded 8-in. oil line showing tied-in sections on timber skids beside ditch.



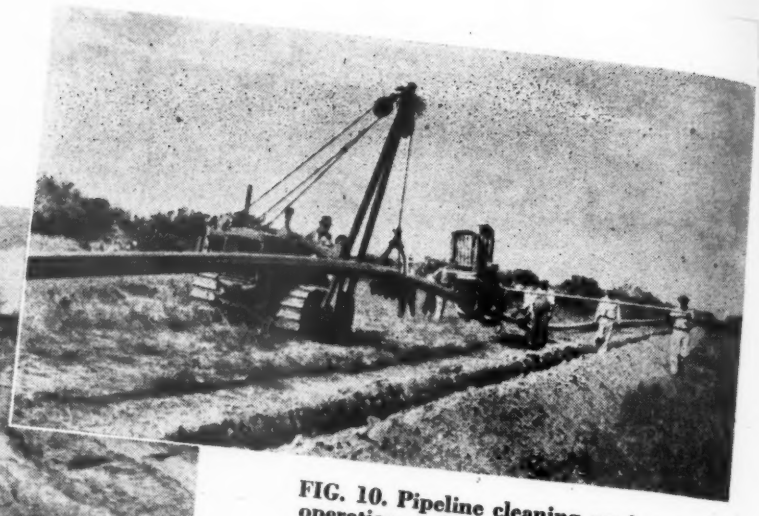
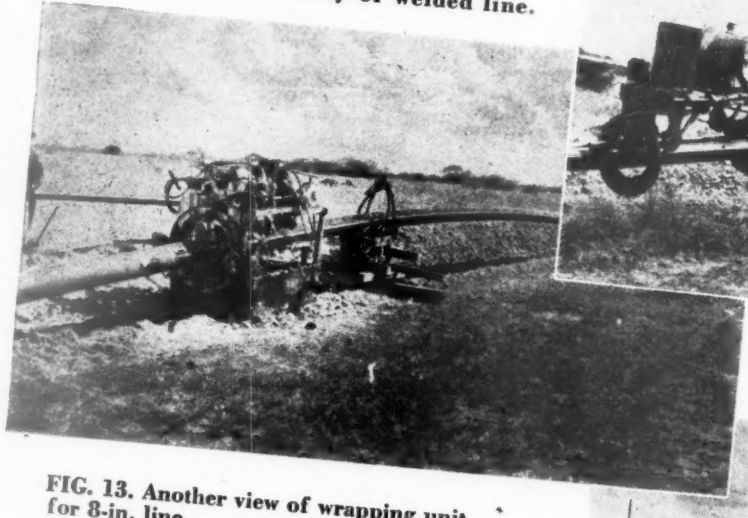


FIG. 10. Pipeline cleaning equipment in operation on long section of welded line.

FIG. 11. Equipment wrapping specially treated paper on pipe for further protection against corrosion. Note flexibility of welded line.



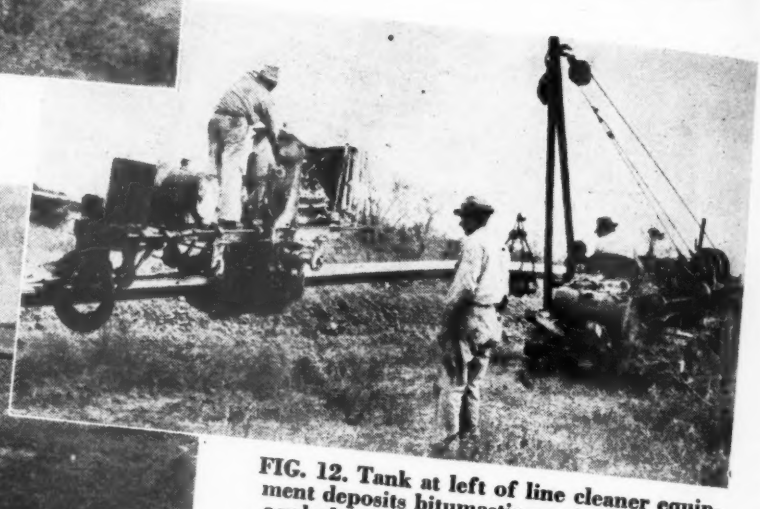


FIG. 12. Tank at left of line cleaner equipment deposits bitumastic coating of cement, asphalt, asbestos, and other chemicals.

FIG. 13. Another view of wrapping unit for 8-in. line.

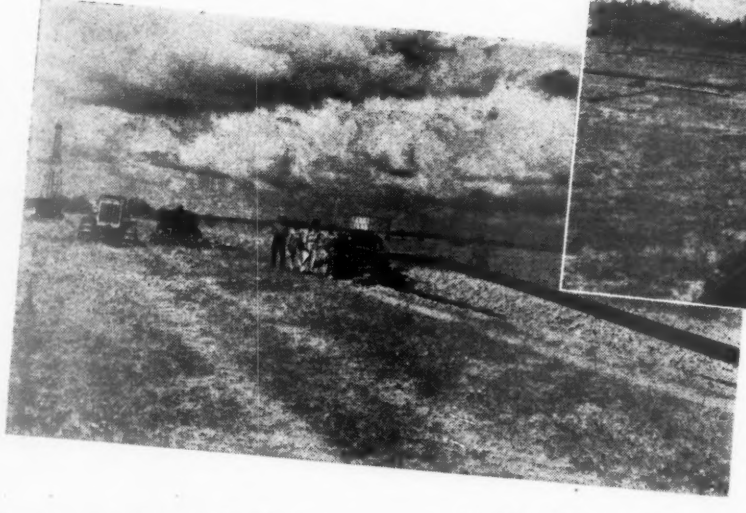
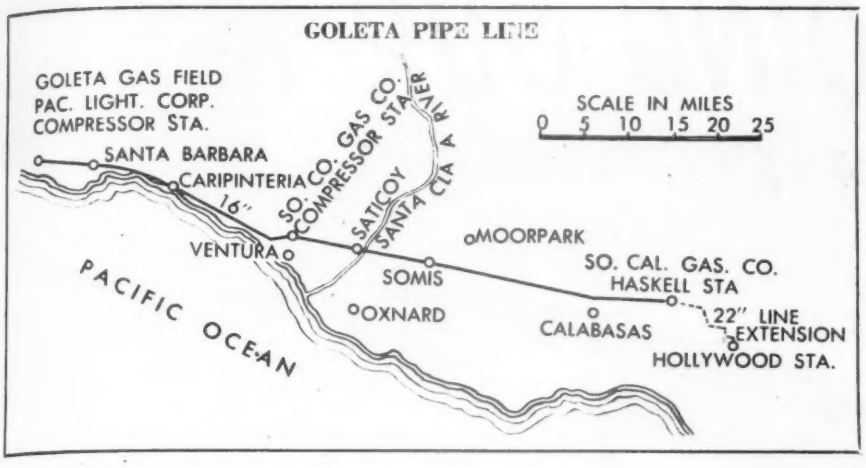


FIG. 14. Filling in the ditch over a stretch of completed pipe line. Note paper-wrapped portion of line in ditch in foreground.

Sternberg, and J. R. Horrigan.

Information on pipe line construction for the last year was also obtained from principal pipe line operators including Gulf Refining Company, Magnolia Pipe Line Company, Sun Pipe Line Company, Sinclair Pipe Line Company, Shell Pipe Line Corporation, British American Oil Company, Ltd., Great Lakes Pipe Line Company, Sunflower Ordnance Works, Simrall Pipe Line Company, Detroit Southern Pipe Line Company, Ohio Oil Company, Union Gas System, Inc., Birmingham Gas Company, United Gas Pipe Line Company, El Paso Natural Gas Company, Tennessee Gas and Transmission Company, and other concerns of this type. ★★★



GOLETA PIPE LINE MEETS DEMAND OF WAR INDUSTRY

By **BARNEY LAULHERE,** Pacific Pipeline Construction Company

EXCLUSIVE SEVERAL innovations in pipe line construction facilitated the laying of a recently completed line from La Goleta dry gas field to Los Angeles. The project was a joint venture of the Southern California Gas Company, the Southern Counties Gas Company, and the Pacific Lighting Corporation. As completed it provides for an increase of 164,000,000 cu. ft. of gas per day for peak day use by customers in essential industries in the Los Angeles area. The work included the drilling of additional wells in the dry gas-reservoir field of La Goleta, the laying of two sizes of pipe lines, the construction of a dehydration plant, and the increase of compressor facilities.

The pipe line is approximately 90 miles in length and consists of 36 miles of 16-in. line from Goleta to the Ventura compressor station and 54 miles of 18-in. line from Ventura to Haskell Avenue station, which is situated on the northwestern edge of Los Angeles. A 22-in. line, 12 miles in length, is now being constructed from Haskell to the Hollywood station of Southern California Gas Company to facilitate further the distribution of this gas. (See accompanying map.) The 16-in. line from La Goleta to Ventura was constructed for Southern Counties Gas Company and the 18-in. line from Ventura to Los Angeles for Southern California Gas Company. The work was done by the Pacific Pipeline Construction Company and the Pacific Crane and Rigging Company.

Span across ravine northwest of Ventura. Hold-back lines and towers are not yet removed.

Construction of line. Planning and engineering for the construction of the pipe line were handled by an engineering committee representing the two gas companies, the construction work for the Southern California Gas Company being under the direction of H. P. George, manager of production and transportation, and that for the Southern Counties Gas Company under the direction of Fred A. Hough, executive engineer. The physical features of the land through which the pipe was laid offered a variety of problems. These included mountains, canyons, rivers, highways, and city streets. In the mountain sections the right-of-way often involved building access roads and making side-hill cuts.

The line was arc welded throughout and was buried except where it crossed canyons; in one place solid rock had to be excavated for approximately one mile. On most sections of the line the trench was excavated to a depth of approximately 4 ft. and had an average width of 28 in. The solid rock excavation was encountered near Somis and this mile section was drilled and shot.

In Santa Barbara the soil was sandy and inclined to cave. Along the ocean front the trench was dug with a ditching machine and then the sections that caved were cleaned out with truck cranes. A sufficient number of sidebooms for laying this length of large diameter pipe was not available so the contractor fabricated 9 sidebooms from 5-in. drill pipe and installed them on tractors with power take-offs.

The stove-pipe method of welding the 40-ft. joints was employed, the pipe being laid by truck cranes or sideboom tractors on two 4 in. by 6 in. skids. Two welders with the line-up crew ran the

(Continued on Page 159)

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(Continued from Page 153)

first pass and the other welders followed to finish the weld by running two or three more passes.

Both the use of a bending machine and the wrinkle-bend welding method were employed for bending the pipe. The bending machine consisted of a bending table with a winch and bending shoe, the bending shoe supporting the pipe so it could be bent cold.

All pipe was wrapped and coated, some in the field and some in the yard. The equipment used for field operations consisted first of a cleaning and priming machine to remove mill scale and dirt and to apply a primer. Following this was a second machine, which applied hot enamel and 12-in. felt wrapping.

The coating and wrapping machine used to treat the pipe at the stock pile was designed and built by the contractor. It was of the lathe type and capable of handling pipe of any diameter from 3 in. to 30 in. It was first set up with a jib crane to handle the 16-in. pipe at a yard situated in Santa Barbara. When this pipe was finished the machine was moved to a yard farther east along the line and set to coating and wrapping 18-in. pipe.

Backfilling operation along highways and method of spanning canyons are among interesting construction features of job.

Backfilling operations in the mountains and in the open areas were comparatively simple but along the highways the State Highway Department required that backfill be air-tamped in layers approximately 4 in. thick. This would require a large crew, which was not available because of the labor shortage. The contractor solved the problem by constructing two special sheepsfoot tampers, which compacted the soil to 160 lb. per sq. in. and, upon testing, met the approval of the highway department. These devices were made by welding sheepfeet on a cylinder 24 in. wide by 66 in. in diameter, the completed cylinder weighing 2 tons. On each tamper there were 120 sheepsfeet spaced 9 in. on centers and so placed that every square inch of the trench bottom was compacted as the tamper rolled along the trench. The tamper was moved by a sideboom with special bridle attachment.

Spanning canyons. Of particular interest was the use of catenary spans to carry the line across canyons. By this method of construction the pipe extends from one wall of the canyon to the other with no cable or any other external support. There are ten of these catenary spans across canyons ranging in width from 187 ft. to 430 ft. At the longest span the lowest point of the pipe is 150 ft. above the canyon floor. The stresses on the catenary type of span are less than with the beam type hitherto commonly used and from the engineering standpoint the catenary span is more conservative and permits the use of longer spans.

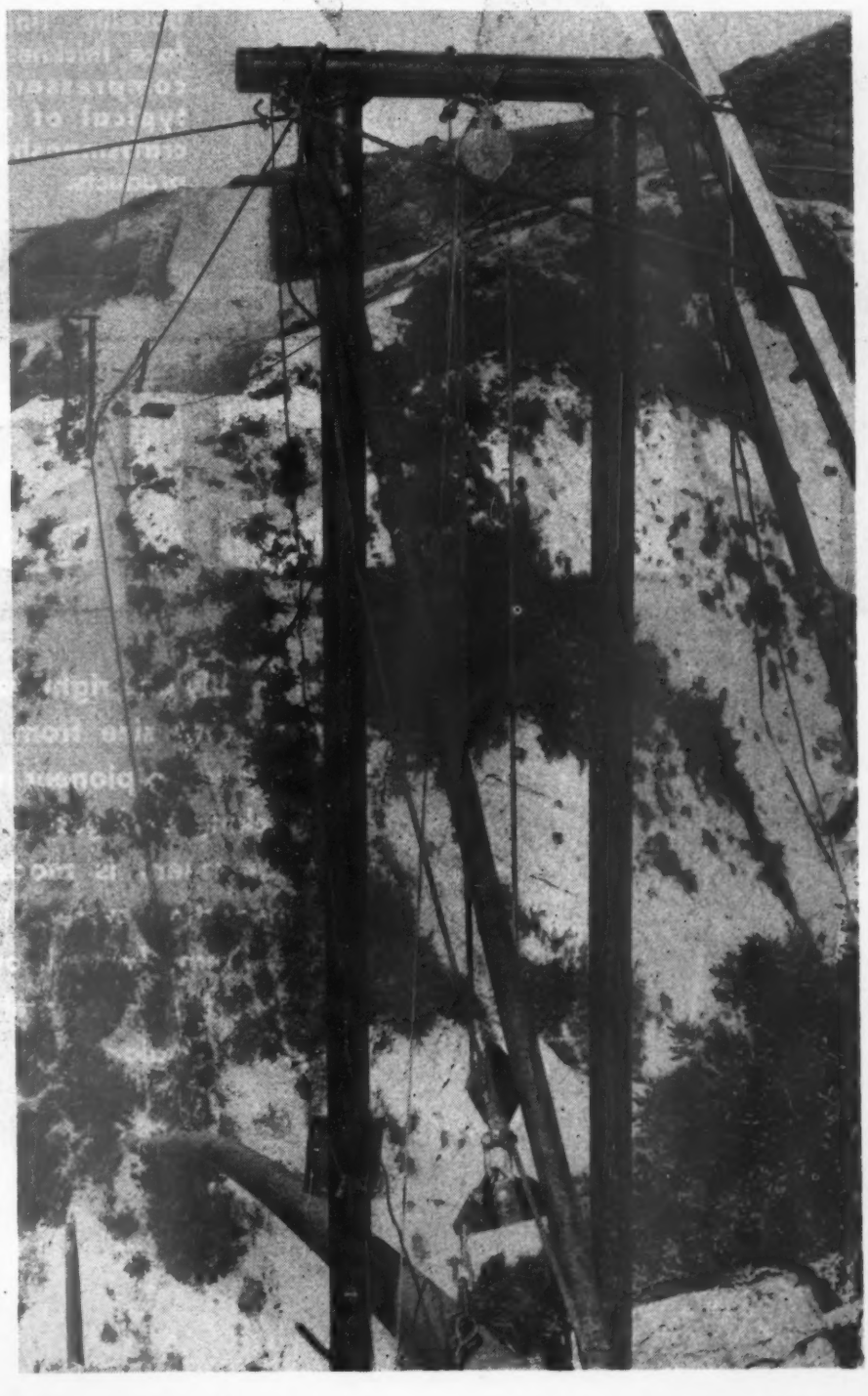
The anchors for the catenary spans consist only of the buried pipe at the bank of the canyon. The transition from the horizontal pipe at the face of the wall to the catenary suspension was made with pre-bent sections of pipe. The pipe across the canyon was allowed to sag and assume the approximate form of a catenary curve. Before installing the span the pipe at each bank was first laid and buried.

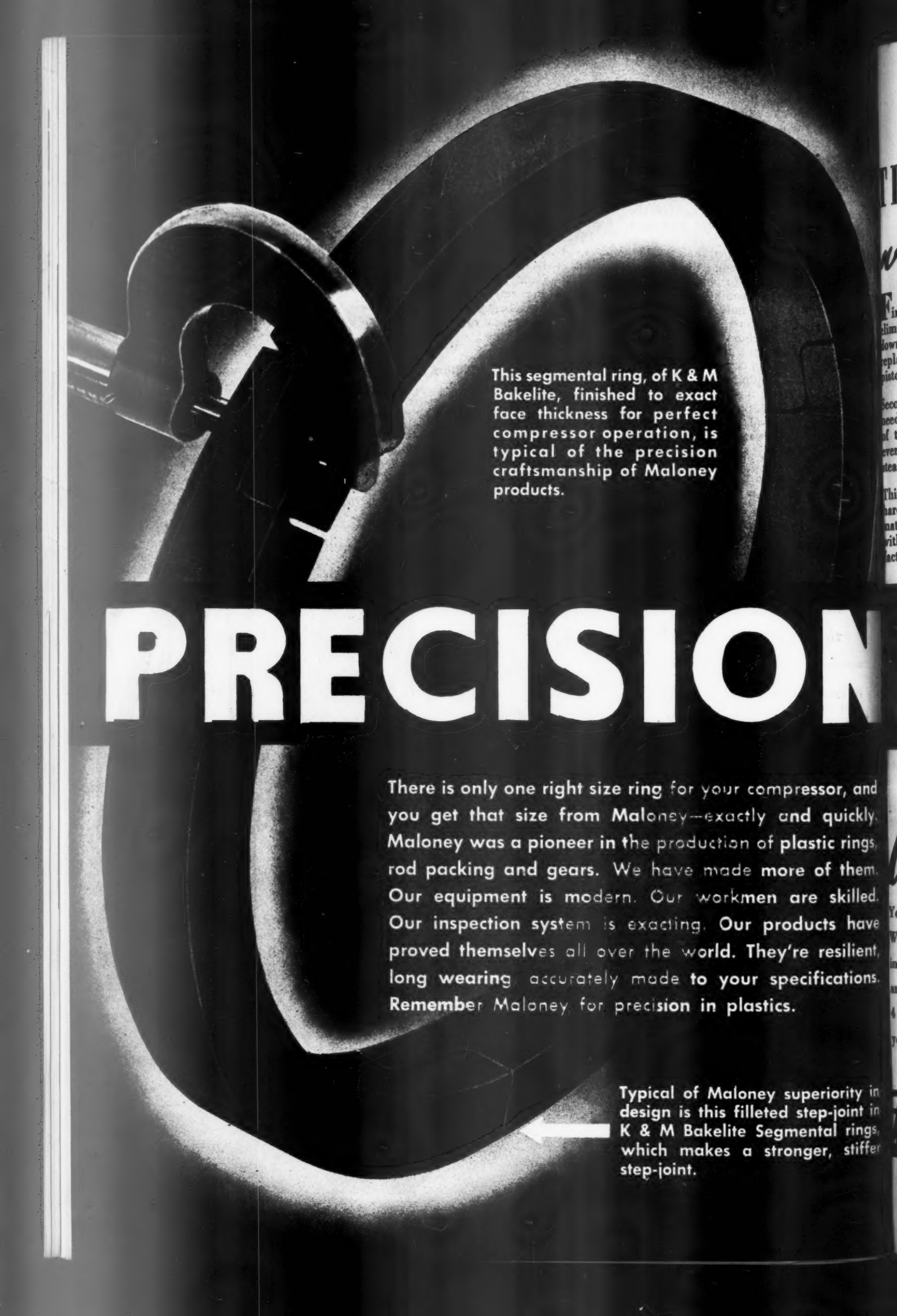
The procedure followed in constructing the span was first to weld a string of pipe of proper length to extend from one anchor to the other. This string was then pulled across the canyon by means of a cable attached to the pipe at approximately 75 ft. from the forward end. The pulling cable passed over sheaves in a 25-ft. tower set up temporarily on the opposite bank.

A hold-back cable passing through sheaves in a similar tower on the near

(Continued on Page 162)

Pulling a 16-in. pipe line across a ravine.




This segmental ring, of K & M Bakelite, finished to exact face thickness for perfect compressor operation, is typical of the precision craftsmanship of Maloney products.
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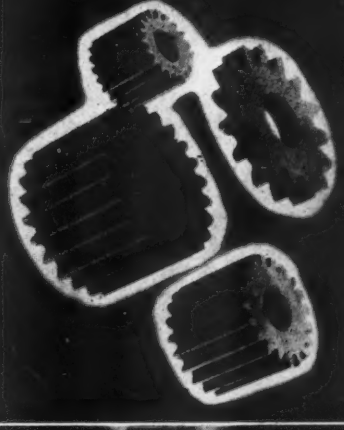

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H. MALONEY Co.

"PRECISION IN PLASTICS AND METALS"

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P. O. BOX 1777 • HOUSTON 1, TEXAS

(Continued from Page 159)

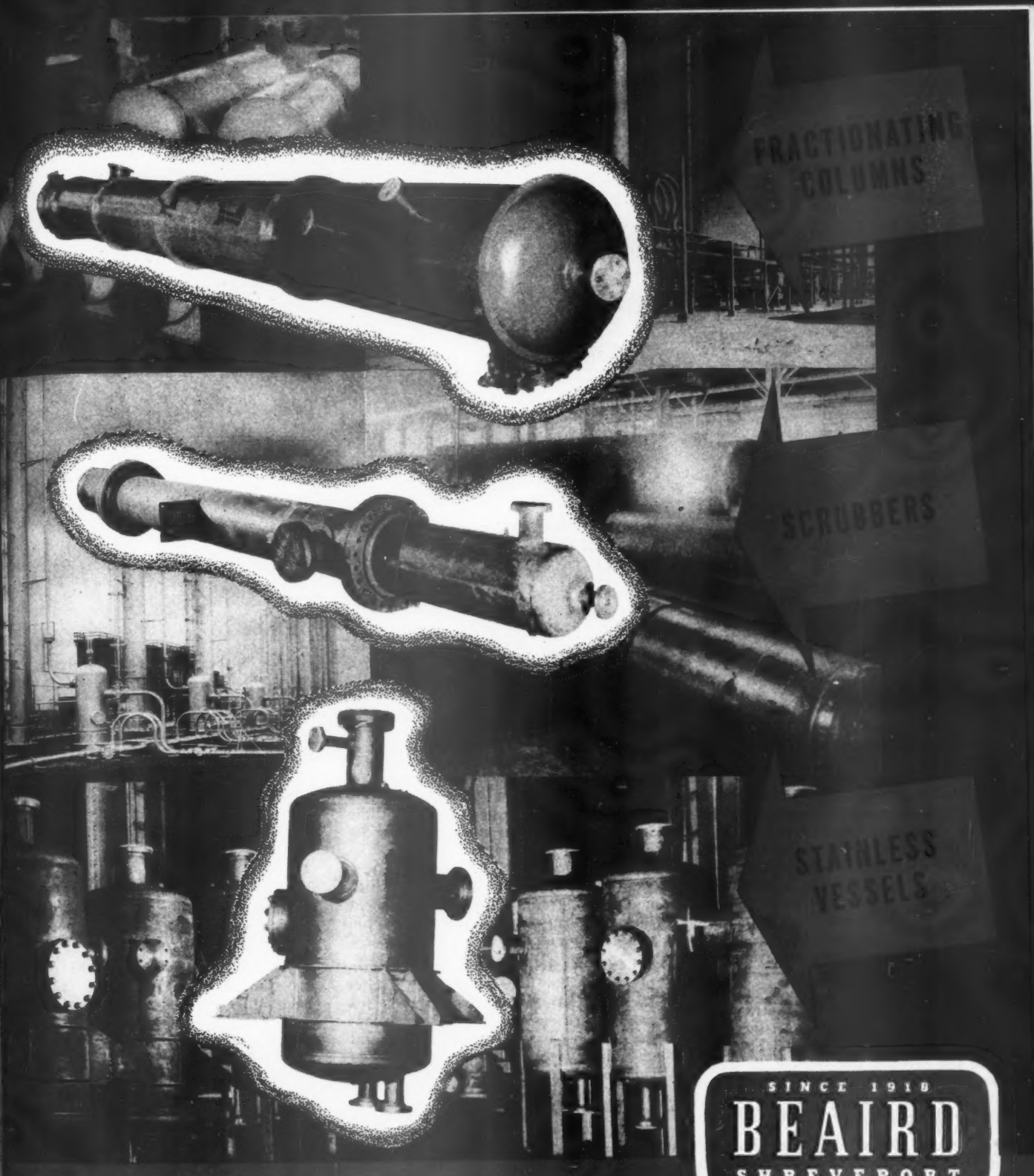
bank was attached to the rear of the pipe string, between 75 and 100 ft. from the end. Support for the pipe was provided at this tower as the string was being pulled across the canyon. When the string reached position across the canyon it was supported by the pulling cable and hold-back cable until the ends were welded to the buried ends of the line at each bank. The span was then allowed to sag into its position.

The minimum radius of curvature taken by the spans was found to be approximately 800 ft. The bending stresses introduced by this curvature were eliminated after the span was installed by heating bands around the upper three-quarters of the circumference of the pipe. These bands were approximately 7 in. wide and were made at 20-ft. intervals. The pipe buckled outward slightly at each band thus heated and formed a so-called "hot wrinkle" such as those sometimes used for bending. Stress calculations were made when designing the spans, and strain gage readings taken at periods during construction and while subjected to hydrostatic tests of 1500 lb. per sq. in. confirmed the calculations.

▸ **River crossing.** At the Santa Clara River two 14-in. lines were laid instead of crossing the bed with the 18-in. line. These were approximately 5400 ft. in length and were placed 10 ft. apart, being connected to each end of the main line by manifolds. Although the Santa Clara River at low water is less than 100 ft. in width and usually less than one in depth during the dry season, in the rainy season it is frequently more than a mile wide and sometimes overflows its banks. During completion last Novem-

(Continued on Page 166)

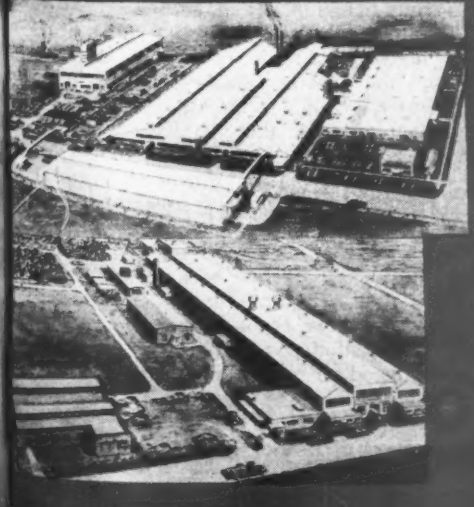
***Above*—Sheepsfoot tamper mounted on side arm tractor used in backfilling along state highway. *Below*—Pipe coating and painting machine in operation on 18-in. line.**



SINCE 1918

BEAIRD

SHREVEPORT



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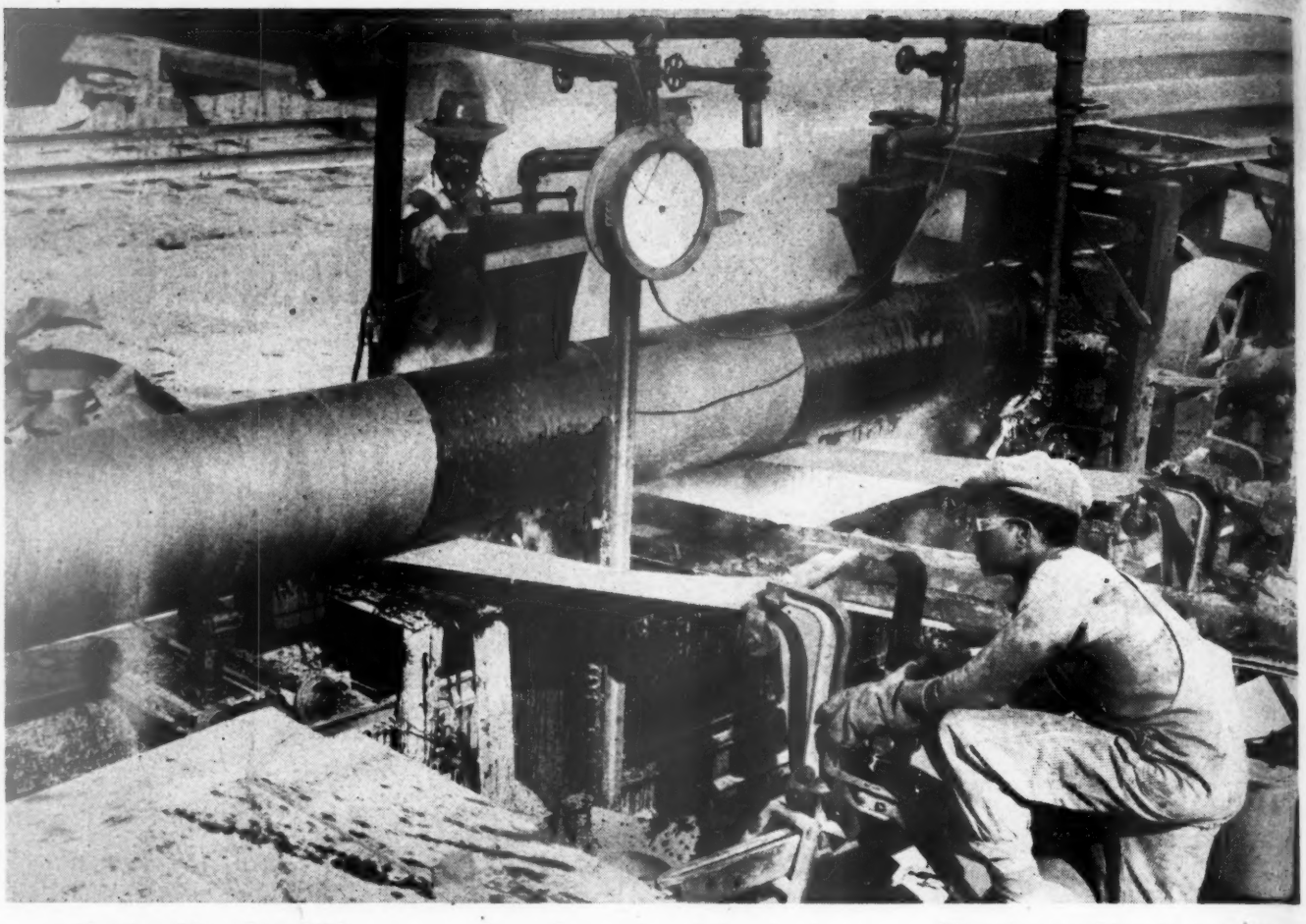


Wrapping machine in operation on 18-in. pipe at Moorpark pipe yard. Part of the line was coated and wrapped in yard, part in field.

(Continued from Page 162)

ber the river carried between 30 and 50 sec.-ft. of water and the depth encountered in excavating reached as high as 25 ft. The location selected for the crossing took advantage of a high promontory of solid ground on the southeasterly bank and thus secured protection for the site.

In crossing the river the pipe was welded as the trench was excavated and then placed in the trench by cranes equipped with slings. When the completed line reached the active stream bed a channel was made to divert the water over the section of pipe that had been laid and covered. The sides of the trench were sloped approximately 1½ to 1 and the material excavated on this part of the work approximated 150,000 cu. yd.

▸ **Cleaning and protection of line.** The interior of the pipe was cleaned by swabbing the joints before they were placed on the skids and lined up. Caps were placed over the ends to prevent entrance of dirt and small animals. Upon final completion of the line final cleaning and finishing was done with the aid of temporary blowout stacks placed at various points ranging from 9 to 25 miles apart. Steel grit was then blown through the line at high velocity by gas under a pressure of 400 lb. per sq. in. By this treatment the dirt and grit was forced out the blowout stacks. Fire fighting apparatus was stationed at the blowout points during this procedure since there was the possibility of sparks igniting the gas upon its contact with the oxygen in the air.

Internal corrosion of the pipe is reduced to a minimum by the dehydration equipment which was installed at the intake. This removes any water from the gas before it enters the line.

Deterioration by electrolysis is prevented by cathodic protection, which neutralizes ground currents. Equipment for this purpose was installed by the two gas companies.

▸ **La Goleta field.** The dry gas field supplying the line is being used by Pacific Lighting Corporation as a reservoir for gas from other fields. For several years the company has augmented the natural gas supply of the field by storage of large volumes of gas taken from other fields during periods when it is not needed and has injected this gas into the sands under pressure.

In order to increase the withdrawal rate of gas and thus meet the requirements of the new line, two additional wells were drilled as part of the project. These wells did not penetrate a new gas zone but were completed in the sands already being produced.

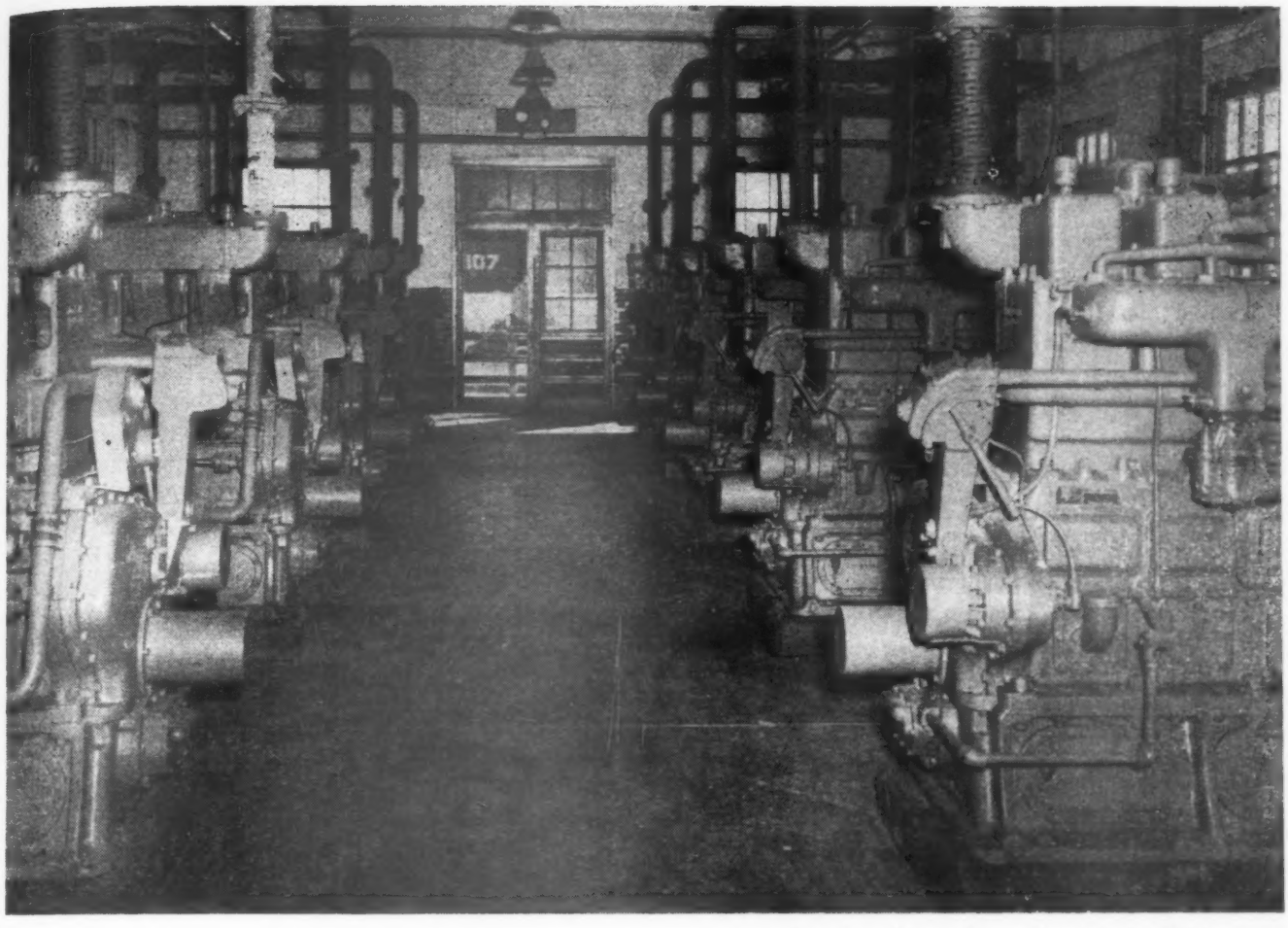
The first well drilled under the project is indicative of the operations. In this well a 13⅜-in. water string was set at 505 ft., 8⅝-in. casing at 4140 ft. and 6⅝-in. liner from 4104 ft. to 4509 ft., the liner being perforated for 243 ft. Production is through the casing but 2-in. tubing was hung to 4489 ft. for cleaning purposes. After cleaning up, production through the tubing was at the rate of 12,900,000 cu. ft. per day and through the casing at the rate of 145,000,000 cu. ft. per day. In producing a maximum rate through the casing the pressure drop at the wellhead was only 300 lb. per sq. in. When shut in after testing the casinghead pressure was 1750 lb. per sq. in.

Part of the new pipe line will be used for transportation of gas to the field from other sources when it is not in service carrying gas to the Los Angeles area during peak periods.

▸ **Plant expansion.** Part of the project was the construction of a pressure limiting station at the Somis plant of the Pacific Lighting Corporation. This station was designed to operate at a maximum pressure of 785 lb. per sq. in. on the section of the line between Somis and Ventura and to limit the downstream pressure to 650 lb. per sq. in.

In addition to the construction of the dehydrating plant at the La Goleta end of the line the compressor capacity for injection of gas into the reservoir was increased by the installation of three new 600 hp. compressors. At the Ventura compressor station of Southern Counties Gas Company new compression cylinders were installed on gas-operated engines. A meter and regulator station at Haskell Avenue, terminus of the 18-in. line, was built under separate contract by The Fluor Corporation, Ltd. At this station the pressure of the gas is reduced for release into the city distribution mains. ★★★

P 615.93



Interior of pumphouse showing the 200-hp. gas-gasoline engines that drive the loading pumps.

LOADING TERMINAL EMBODIES NEW FEATURES

By **FRANK H. LOVE,** *Managing Editor*

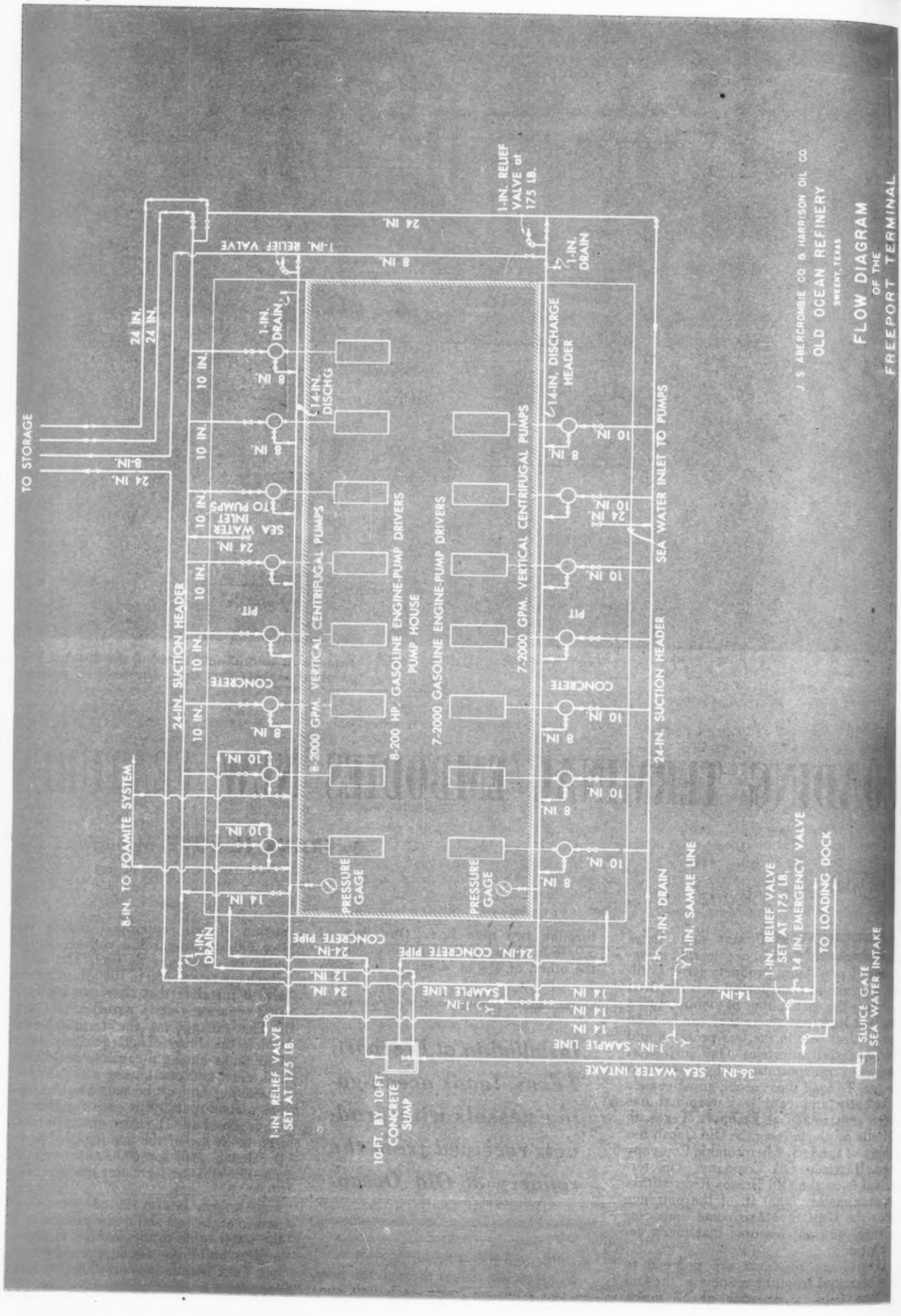
EXCLUSIVE DURING these times of accelerated movement of petroleum products every available means of transportation is required to place the vast volume of manufactured fuels at locations where they can be used most effectively in the war program and for essential industries. One such vital means of transportation is by tanker and barge. To load these ocean-going vessels efficiently and rapidly a terminal has been constructed at Freeport, Texas, to handle products from the Old Ocean Refinery of the J. S. Abercrombie Company and Harrison Oil Company. The terminal is on the Old Brazos River within approximately 8000 ft. of the entrance into the Gulf of Mexico and embodies several unusual features that merit description.

Petroleum products are pumped to the terminal from the refinery in the Old Ocean field, a distance of 32 miles, through two pipe lines. One line, of 5 9/16 in. diam., is for aviation gasoline; the other, of 4½ in. diam., is for motor gasoline and diesel or furnace oil.

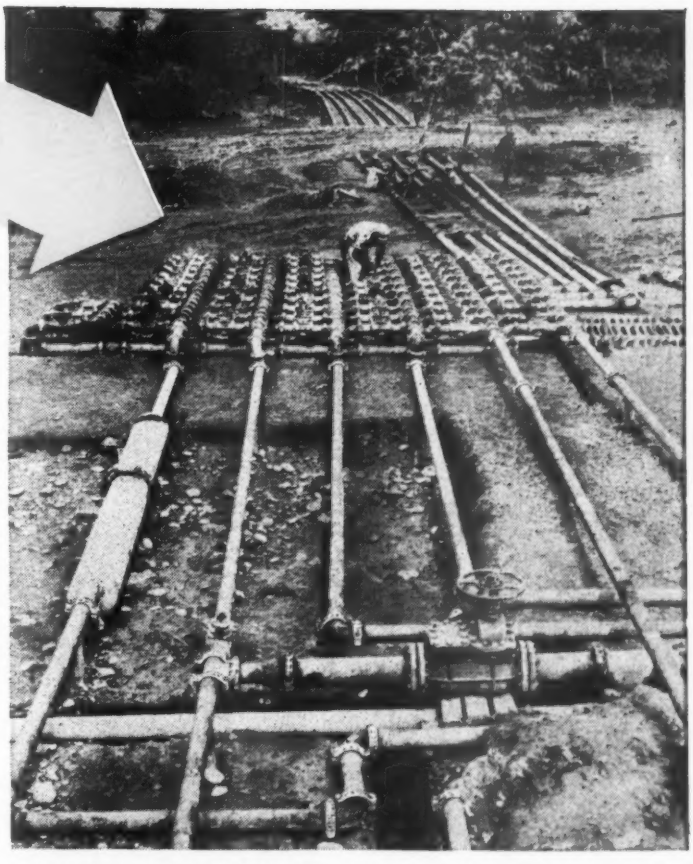
Installation at Freeport, Texas, loads ocean-going vessels with products received from the refinery at Old Ocean.

Products are moved through the lines by two pumping units, each unit consisting of two centrifugal pumps and two 200-hp. gas-gasoline engines, in this instance using gas as fuel. The units, which operate at 650 to 1000-lb. pressure, are so installed that they can be operated separately or in parallel.

The tankage at the terminal into which the lines discharge consists of four tanks having a capacity of 100,000 bbl. each and one having a capacity of 30,000 bbl. One of the 100,000-bbl. tanks has a cone roof and is used for furnace oil or diesel oil. The other three 100,000-bbl. tanks are of the floating roof type; two being used for 100-octane aviation gasoline and one for motor gasoline. The 30,000-bbl. tank is used for bunker C fuel storage. Due to the unconsolidated nature of the soil and to the proximity of the water table to the surface, tanks, as well as buildings, are supported on piling. Tank foundations are concrete slabs supported by 40-ft. piling driven on 4-ft.


FLOW DIAGRAM
OF THE
FREEPORT TERMINAL
J. S. ABERCROMBIE CO. & HARRISON OIL CO.
OLD OCEAN REFINERY
SWEENY, TEXAS
TO STORAGE
24 IN.
24 IN.
8-IN.
24 IN.
1-IN. RELIEF VALVE
8 IN.
1-IN. RELIEF VALVE at 175 LB.
1-IN. DRAIN
14-IN. DISCHG
14-IN. DISCHARGE HEADER
SEA WATER INLET TO PUMPS
24-IN. SUCTION HEADER
10 IN.
PIT
CONCRETE
8-IN. TO FOAMITE SYSTEM
14 IN.
PRESSURE GAGE
7-2000 GPM. VERTICAL CENTRIFUGAL PUMPS
8-200 HP. GASOLINE ENGINE-PUMP DRIVERS
PUMP HOUSE
7-2000 GASOLINE ENGINE-PUMP DRIVERS
24-IN. CONCRETE PIPE
12 IN.
1-IN. SAMPLE LINE
1-IN. DRAIN
1-IN. RELIEF VALVE SET AT 175 LB.
14 IN. EMERGENCY VALVE
TO LOADING DOCK
SLUICE GATE
SEA WATER INTAKE
36-IN. SEA WATER INTAKE
10-FT. BY 10-FT. CONCRETE SUMP

WORLD'S LONGEST PIPELINE — Part of a 2000-mile line from India to China. Laid through some of the worst terrain in all the world, this line is subjected to every imaginable strain . . . It is coupled by Victaulic.



WAR BONDS
A PIPE LINE FROM YOU TO HIM

The terrific job of "fueling" our armies overseas does not end when the tankers unload at the ports. Too little known is the amazing story of the thousands of miles of Army pipelines that are laid at top-speed, often under fire — and must be able to withstand extreme strains of terrain and battle conditions. Millions of Victaulic couplings have been used on these Army pipelines — for these two special reasons . . . their speed and ease of assembly . . . their ability to provide a flexible, leak-tight joint, and to go on providing it under even the worst conditions.

THROUGH JUNGLE RIVERS the fast-working 775th Army Engineers lay part of the 2000-mile vital pipeline. Despite the constant pressure of powerful river currents Victaulic couplings insure lock-tight, leak-proof joints.

SO THAT YOU can find out more about these Couplings, get the color-illustrated Victaulic Catalog and Engineering Manual. No obligation — simply drop us a line on your company letterhead. Write to: VICTAULIC COMPANY OF AMERICA, 30 Rockefeller Plaza, New York 20, N. Y. Other Victaulic offices — Victaulic Inc., 727 West 7th St., Los Angeles 14, Cal.; Victaulic Co. of Canada, Ltd., 200 Bay St., Toronto.

VICTAULIC

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SELF-ALIGNING PIPE COUPLINGS AND FULL-FLOW FITTINGS

OIL MINING MARINE MUNICIPAL INDUSTRIAL

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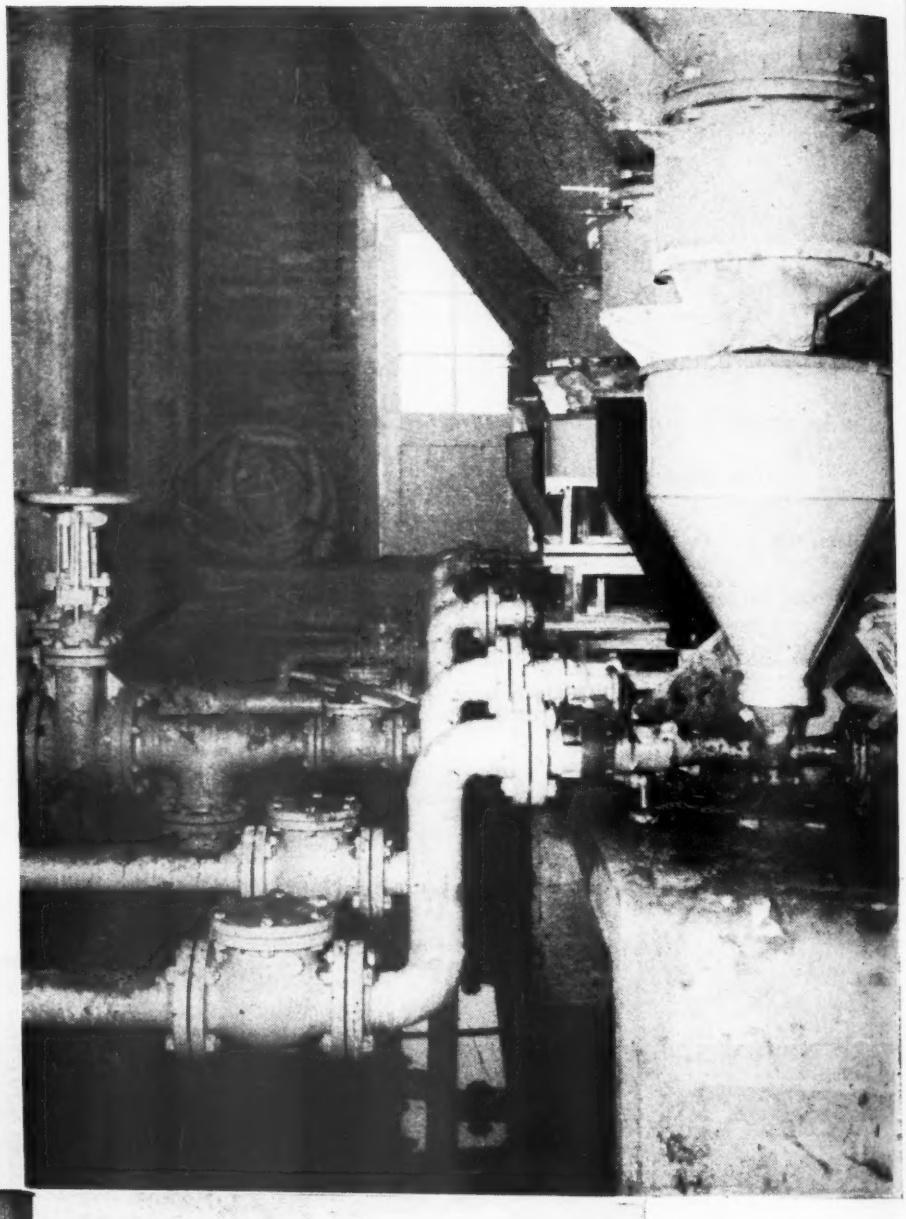
centers. Buildings do not require such close spacing of piling.

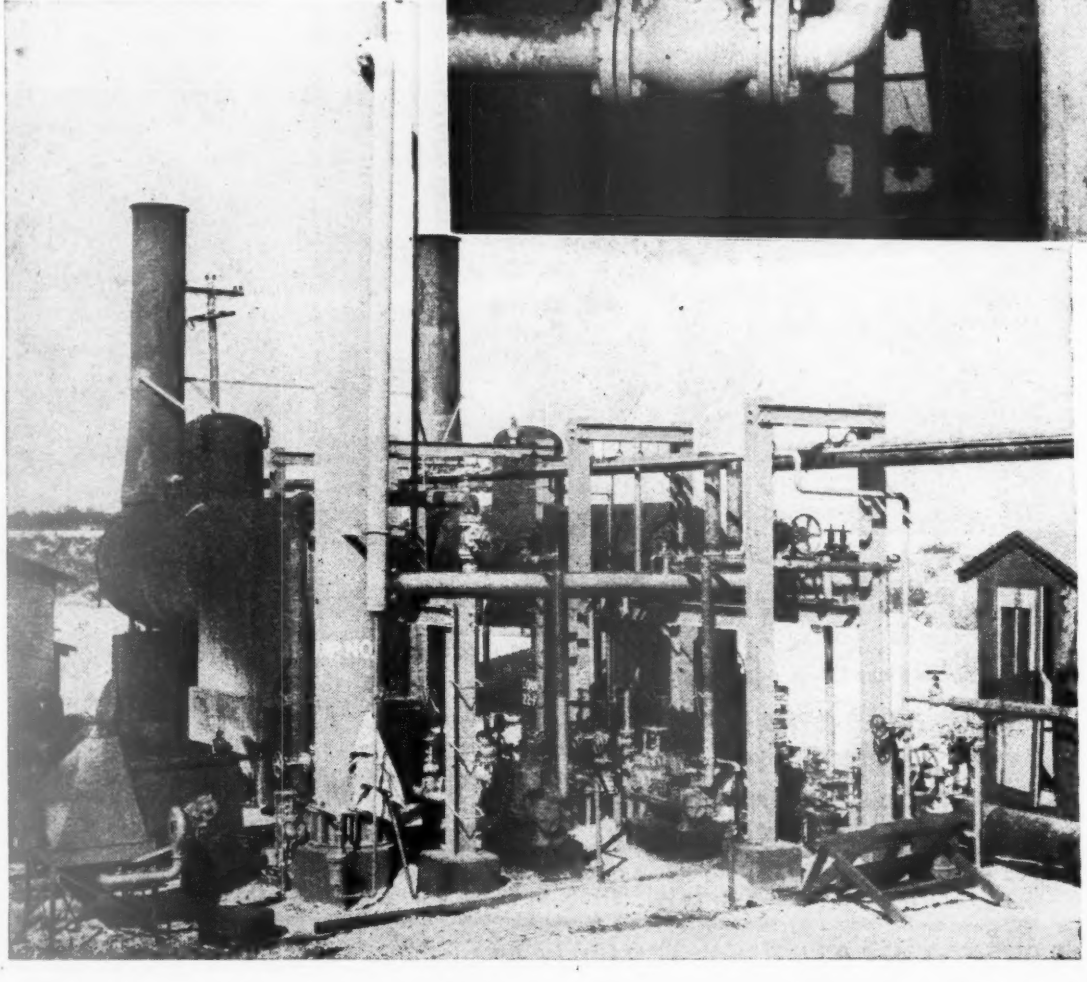
The loading pump set-up is somewhat unusual for terminal installations. For this service deepwell type vertical centrifugal pumps are used. These are installed outdoors on each side of the pumphouse, seven on one side and eight on the other, with the suction ends below ground in concrete pits and the power ends above ground. This constitutes a new use for this type pump and has substantially improved suction conditions. The 200-hp. gas-gasoline engines that drive the pumps are inside a brick pumphouse and power the pumps through gear heads having a ratio of 2 to 1. Customarily the pumps are operated at 750-800 r.p.m. At this speed each pump delivers 1800-1900 gal. of fluid per minute. The engines, in this instance, use gasoline for fuel.

From the storage tanks 24-in. suction lines connect into 24-in. headers, the latter being in concrete pits that measure 90 ft. long by 12 ft. wide by 12 ft. deep. The loading pumps take suction from these headers and discharge to the dock through two 14-in. lines. At the dock each discharge line has four 10-in. spots with a 10-in. swivel joint on each spot. Two heavy-duty wooden hose booms are also a part of the dock equipment.

As protection against fire an up-to-date foamite system has been installed. A brick building houses the mixing hoppers and sea water is used to mix with the foamite powder. The sea water in-



Foamite mixing hoppers.



Steam plant consisting of two 125-hp. oil field type boilers.

Adaptable! Reclaimable!

IN OIL FIELD AND REFINERY USES

ROLAGRIP

PIPE COUPLINGS

ONLY 3 PARTS
for Quick Installation

GASKET—TWO HOUSING HALVES
BOLTS to Hold Them Together

With Rolagrips, oil lines can be laid on the ground, under ground or in the water with assurance of leakproof connections. These simple, positive couplings not only are adaptable to the kind of line but also to the kind of pipe! Any plain end pipe is satisfactory, new or used. Since threading, grooving or flanging are eliminated, lighter weight pipe can be utilized. The gasket is simply stretched over the two pipe ends, centered over the joint and the halves of the housing bolted together without need of special tools or skilled workmen.

100% RECLAIMABLE

In some uses, the pipe itself may wear through completely and have to be renewed frequently, but it is not necessary to renew Rolagrip Couplings. They are completely salvaged and used on one job after another. These factors, in addition to flexibility and shock-resistance, combine to make them ideal for temporary as well as permanent lines.

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ESTABLISHED 1898

ARMY E NAVY

GUSTIN-BACON MFG. COMPANY

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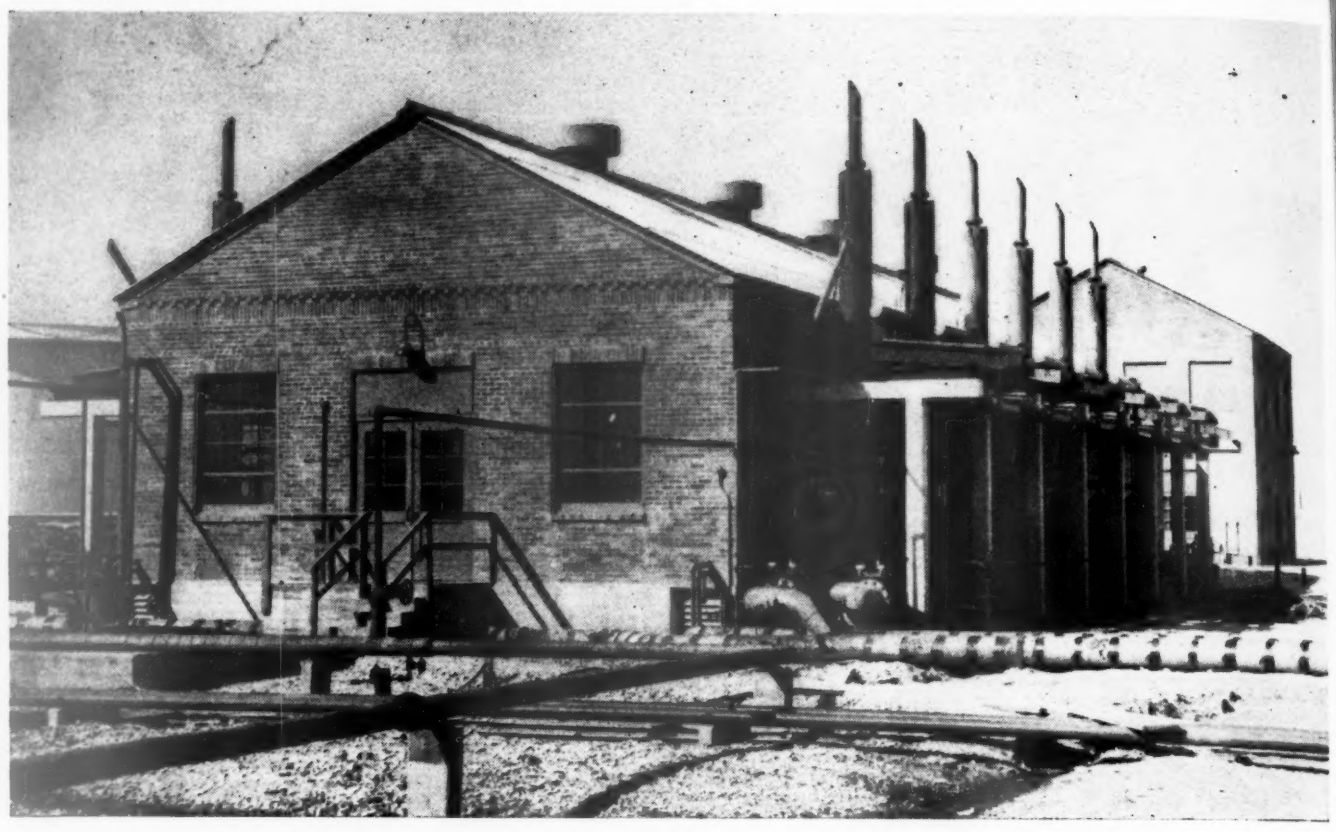
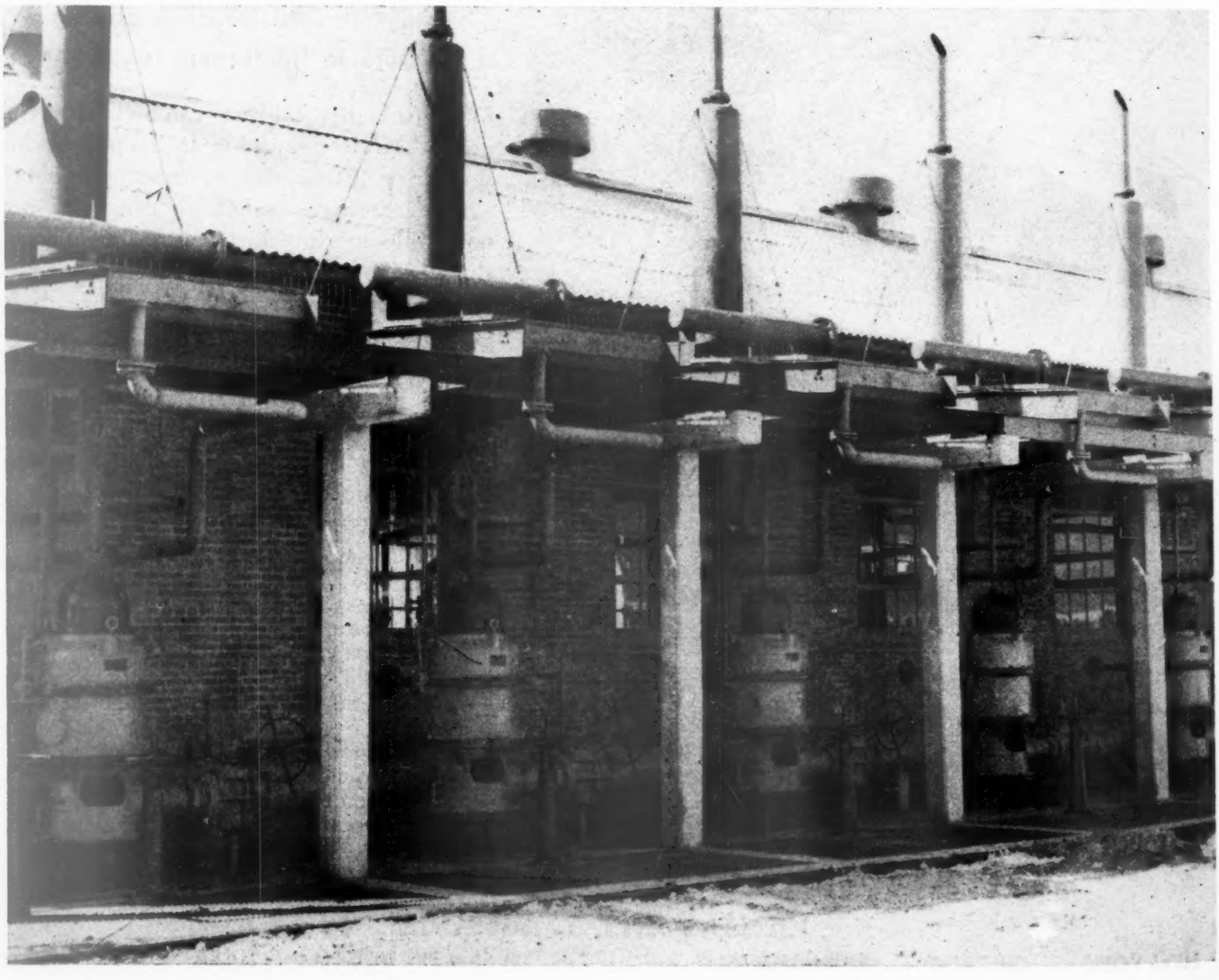
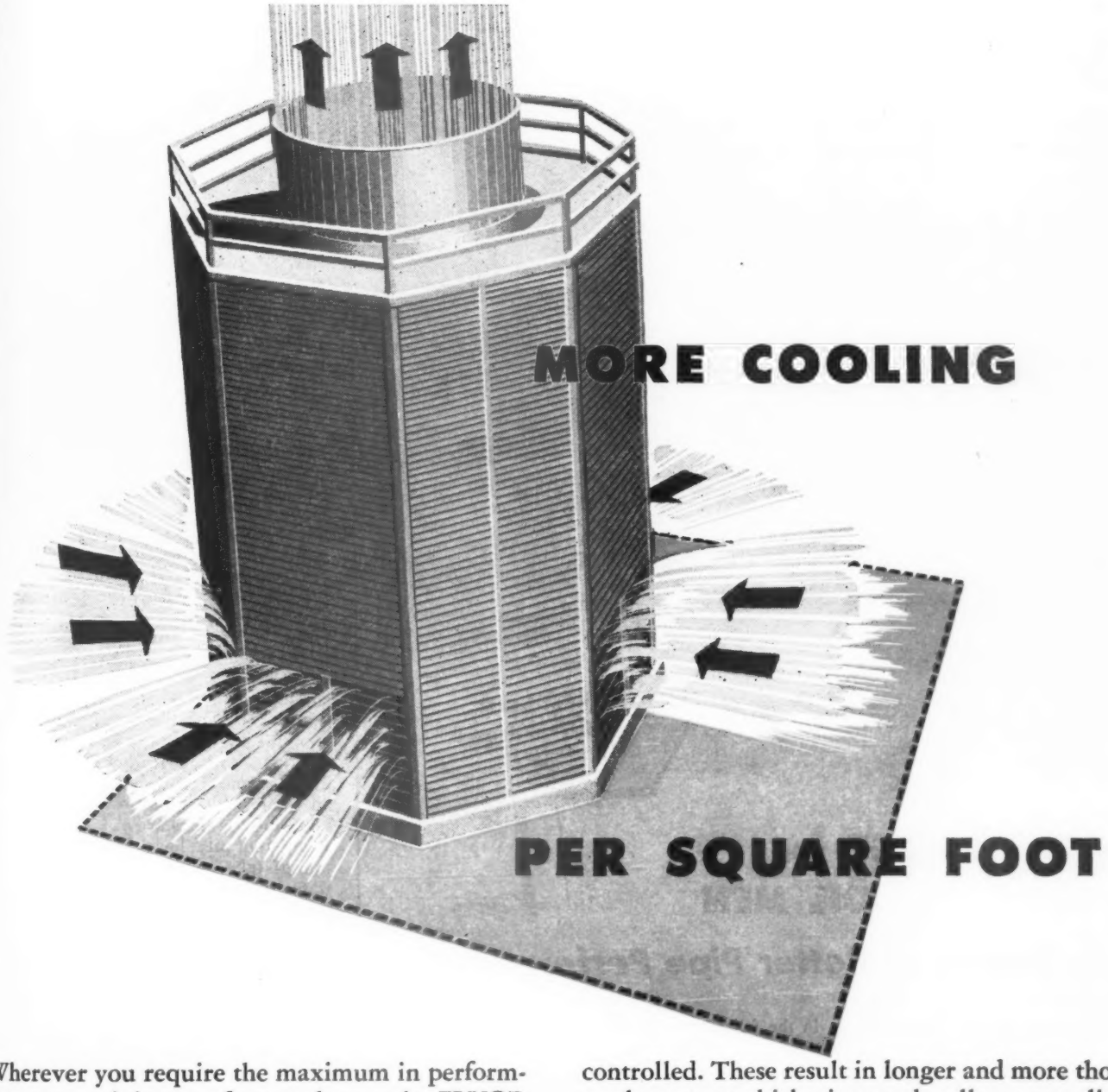
NEW YORK CHICAGO PHILADELPHIA HOUSTON SAN FRANCISCO TULSA FORT WORTH



Above—Pumphouse in foreground and building that houses foamite system in immediate background. *Below*—A part of the deep well type vertical centrifugal loading pumps.





Wherever you require the maximum in performance on a minimum of ground area, the FLUOR Counter-Flow Induced Draft Cooling Tower is the answer. Not only does it provide more cooling per square foot of base area . . . it makes possible a substantial reduction in the amount of concrete, reinforcing steel, other materials and labor since the basin required is also smaller.

The Fluor CFN Cooling Tower more nearly approaches the optimum efficiency of true counter-flow heat transfer. Due to new design water break-up is improved and air distribution better controlled. These result in longer and more thorough contact which gives each cell more cooling capacity than the old style conventional tower. Greater heat transfer per unit of ground space also reduces the number of fans and mechanical equipment required.

All designs for FLUOR Aerator Cooling Towers and FLUOR Counter-Flow Induced Draft Cooling Towers are fully protected by U. S. Patents and Patents Pending.

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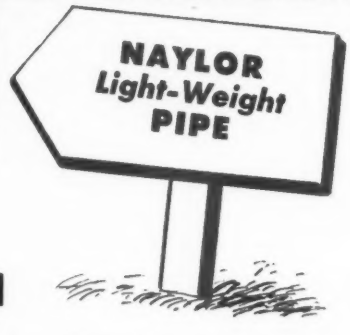

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De-watering pipe	*Surface casing (threaded)*
Gas and oil lines	*Vacuum lines*
Gas and oil gathering lines	*Syphon pipe*
Salt water disposal lines	*Tank gauge pipe*
Sludge lines	*Tank swing pipe*

This light-weight pipe is built to handle jobs normally requiring heavier-wall pipe. Its exclusive Lockseam Spiralweld structure makes it stronger, leaktight and safer than ordinary light-weight pipe. Its accurate diameter and standard weight ends speed installation and cut costs.

Sizes from 4" to 30" in diameter—thickness from 14 to 8 gauge—lengths up to 40 feet. All types of fittings, connections and fabrication.

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General Office
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take is a 36-in. concrete pipe that connects a sluice gate with a 10-ft. by 10-ft. by 12-ft. concrete sump. Two of the centrifugal pumps take suction from this sump through a 12-in. line and discharge through an 8-in. line to the foamite system. There are three hoppers, each of which holds 20,000 lb. of foamite powder. The hoppers are partitioned and each contains 10,000 lb. of A powder and 10,000 lb. of B powder. The A and B powders are carried through separate lines to mixing chambers at the top of each tank where they are brought together to form foam. In case of fire such foam will provide an effective means of applying a fire-smothering blanket to the burning surface of the tank.

As the Gulf Coast of Texas is sometimes visited by tropical hurricanes, an ingenious method has been provided to prevent collapsing of the tanks should a sudden storm find them empty or nearly so. This is done simply by filling the tanks with sea water; however, the manner in which this is done and the rapidity with which it is accomplished constitute the ingeniousness of the method. Should this emergency occur, the sluice gate is opened, permitting sea water from the river to flow by gravity through the 36-in. concrete sea water intake line into the 10-ft. by 10-ft. by 12-ft. concrete sump previously mentioned. Through two 24-in. concrete lines the water flows from the sump into the pump pits, flooding them. The entire procedure of flooding the pump pits is quickly accomplished because the pits are 5 ft. below sea level and the lines are of large diameter. After the pits have been flooded the pumps take suction and pump the sea water into the empty or partially empty tanks. The time required to fill the tanks by this method is but a matter of a few hours.

A steam plant consisting of two 125-hp. oilfield type boilers has been installed to provide steam for several purposes. One use of the steam is to operate two "mud hog" pumps, which are the same type pumps that are used to circulate mud on drilling operations. In this instance they are used to load bunker C fuel oil into tankers. Other uses for the steam are for the smothering lines to the pumphouse and pump pits and for domestic steam for heating purposes. Inside the 30,000-bbl. tank that is used for bunker C fuel storage are 5000 ft. of 1½-in. coil and through this coil steam is passed to keep the fuel oil in flowing condition. At times, also, it is necessary to supply a ship with steam, and for this purpose a 3-in. line has been laid to the dock.

With the terminal facilities as herein described loading rates are extremely flexible and can be exceptionally fast. Sufficient pumping capacity has been provided to accommodate any size tanker, at its maximum rate of intake, and to handle various types of products without contamination. ★★★

BUY WAR BONDS

ECONOMIC PREVENTION OF EVAPORATION LOSSES

By **H. J. D'ARAGON,** *Conservation Engineer*
Graver Tank and Manufacturing Company, Inc.

EXCLUSIVE THE rapid development and perfection of evaporation saving equipment brought about in the last decade through the enlightened demand of the majority of oil companies, has resulted in the ever-increasing number of evaporation-conscious engineers throughout the petroleum industry. The tremendous savings effected by the installation of even the most indifferent conservation devices has an undeniable appeal, not only to the technical man, but to anyone connected with the petroleum industry and familiar with the large volumetric losses of product and attendant greater losses in the quality of volatile petroleum products stored in conventional cone roof tanks.

Unfortunately, this natural appeal often results in over-enthusiastic converts who will recommend this or that type of equipment as a cure-all to be used as the solution to every evaporation problem. This results in inevitable errors in judgment, which in the light of later analysis often reacts against the particular type of equipment in question. The average evaporation problem is too complex—the many variables affecting it often too little understood—for the engineer to find a happy solution through snap judgment or rule-of-thumb method. and although it would seem hardly possible that the installation of any credited type of equipment would not effect considerable saving and thus partly justify the engineer's choice, such installations are very often responsible for the indifferent attitude of some petroleum men toward some effective types of evaporation prevention devices.

By far the greatest single factor responsible for many poorly designed installations is the lack of consideration on the part of the engineer of the simple basic principles involved, and it is not uncommon to find a conservation system carefully and conscientiously designed in detail from an operating and maintenance point of view that must nevertheless be considered of questionable economic justification. As is often the case, a little preliminary reflection on the elementary principles of physics involved would have guided an otherwise competent engineer to an economic solution.

The molecules of any liquid are in constant motion and this motion becomes more rapid as temperature increases. If motion of the molecules becomes violent enough to cause them to break away from the liquid entirely and exist as gas molecules, evaporation is then said to take place. Liquid that will evaporate at normal operating temperatures is called volatile liquid.

If a volatile liquid is placed in an open container, it will gradually dissipate into the atmosphere at a rate depending on the character of the liquid and the temperature. If placed in a closed container, evaporation will continue at a decreasing rate until a state of equilibrium is reached between the liquid and the vapor, and the vapor space is then said to contain a saturated vapor. Saturation occurs when the number of molecules breaking away from the liquid to become a gas equals the number returning from the gaseous to the liquid state.

If restricted in a closed container, the vapors from a volatile liquid will exert a force known as vapor pressure, which is a measure of its tendency to vaporize. The vapor pressure of a liquid increases in direct proportion to the temperature and is wholly independent of the size or shape of the vapor space.

The rate of evaporation from a volatile liquid increases as the temperature increases. It increases with the rate of removal of vapor by air currents that carry off vapors from the surface of the liquid.

Evaporation is greater when the air in contact with the liquid surface is dry, rather than when it contains vapor, and saturation will take place more quickly.

According to the laws governing the behavior of gases, the relationship of pressure, temperature, and volume is expressed by the following formula, which is a combination of the laws of Boyle and Charles: $\frac{P\ V}{T} = \frac{P^1\ V^1}{T^1}$

Where:
P and P^1 = abs. pressure, lb. per sq. in.
V and V^1 = volume, cu. ft., and
T and T^1 = absolute temperature

In studying the behavior of a mixture of gases such as gasoline vapor and air found in the vapor space of storage tanks, a clear understanding of the law of partial pressures (Dalton's Law) is necessary. This law states that in a mixture of gases, each gas exerts a pressure equal to the pressure that it would exert if it occupied the entire volume by itself, and the total pressure of the mixture is equal to the sum of the pressures of its component gases. (The pressure exerted by each component gas in called its partial pressure.)

TABLE 1
Standing evaporation losses—motor gasoline.

Losses per year from cone roof, gas-tight storage tanks equipped with conventional pressure and vacuum valves.

Tank capacity, bbl.	Loss per cent of capacity per year	Loss in gal. per year
1,500	5½	3,465
2,500	5	5,250
5,000	4½	9,450
10,000	4	16,800
15,000	3½	22,050
25,000	3½	36,750
37,500	3¼	51,198
55,000	3	69,300
80,000	2.6	87,400

TABLE 2
Expansion roof capacities.

Tank capacity	Dimensions		Expansion capacity, 8-ft. lift	Expansion capacity, 10-ft. lift
Barrels	Diameter	Height	cu. ft.	cu. ft.
1,008	20 ft.	18 ft.	1,630	3,260
2,088	25 ft.	24 ft.	2,530	5,060
3,024	30 ft.	24 ft.	3,680	7,360
5,130	35 ft.	30 ft.	4,915	9,830
7,504	40 ft.	33 ft. 6 in.	6,450	12,900
10,188	45 ft.	36 ft.	8,080	16,160
15,050	50 ft.	43 ft.	10,015	20,030
20,120	60 ft.	40 ft.	14,400	28,800
25,002	70 ft.	36 ft. 6 in.	19,520	39,040
35,800	80 ft.	40 ft.	25,450	50,900
45,320	90 ft.	40 ft.	32,165	64,330
55,960	100 ft.	40 ft.	39,665	79,330
80,560	120 ft.	40 ft.	57,100	114,200
109,640	140 ft.	40 ft.	77,480	154,960

▸ **Boiling losses.** In considering evaporation losses and their prevention, we find that the problem of protecting products that boil at atmospheric pressures under normal operating tank temperatures is generally well understood. "Pressure storage" in individual units for products in the higher vapor pressure range is accepted, well-defined practice. Such vessels are designed to withstand a slightly greater pressure than that which must be built up in the vapor space in order to stop boiling of the liquid. Pressure vessels are designed from a working pressure of approximately 3 lb. per sq. in., sufficient to prevent boiling losses in the grades of natural gasoline most commonly used, to 100 lb. per sq. in. or more for storage of liquefied petroleum gases.

▸ **Breathing and filling losses.** Economic storage of products in the lower vapor pressure range, such as crude oil motor gasolines and some of the natural gasolines, depends on the successful elimination of breathing losses and filling losses. These two expressions are used profusely by petroleum engineers and their importance is never minimized. It is questionable, however, whether their magnitude and their relation to the specific problem are always as carefully weighed as the importance of the values involved merit.

Breathing may be considered as a continuous process. Daily temperature variations cause air to be drawn into the tank at night. During the day as the temperature rises, this air absorbs vapor and the air-vapor mixture is expelled.

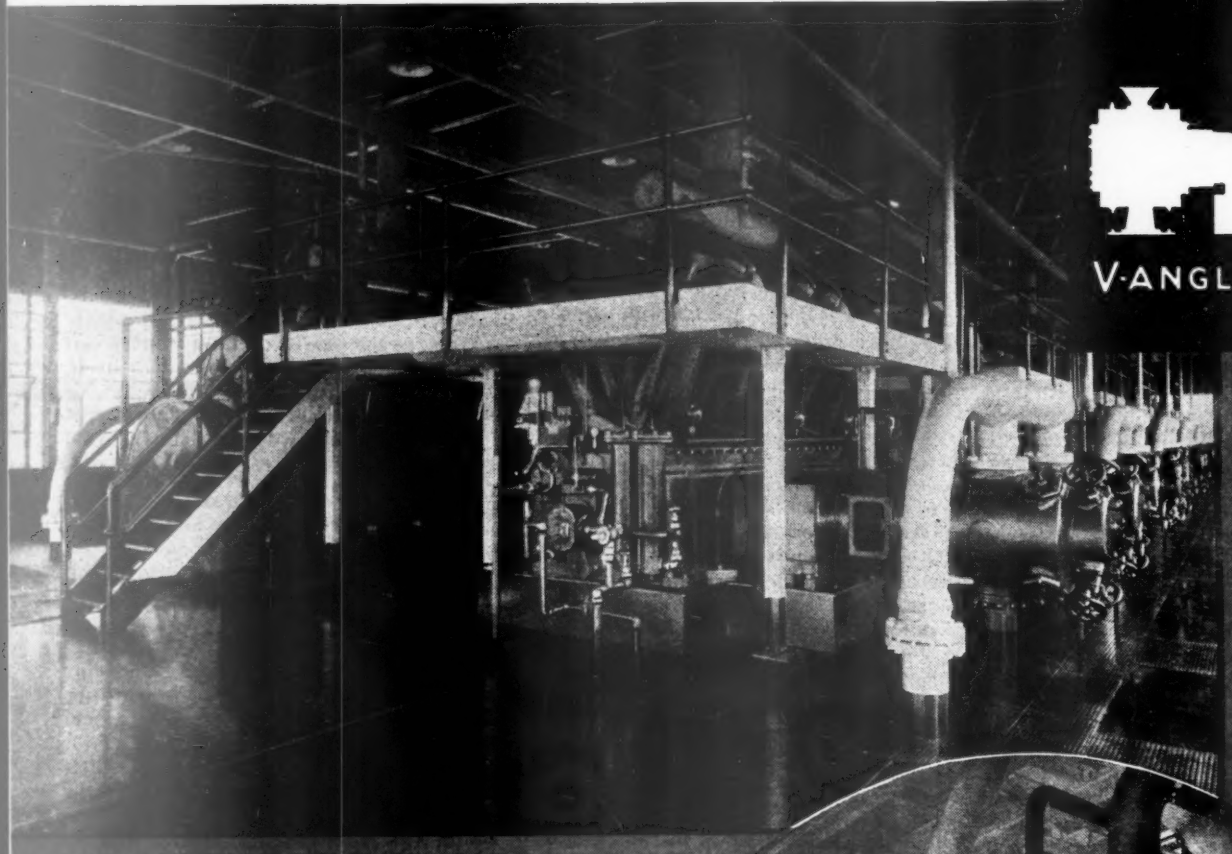
Filling losses occur periodically each time an additional product is introduced into a cone roof tank partially full of a volatile liquid. As the product is pumped in, the displaced air-vapor mixture is forced out through the vent.

It is obvious that although breathing losses occur daily during the entire year, filling losses take place only when prod-

(Continued on Page 182)

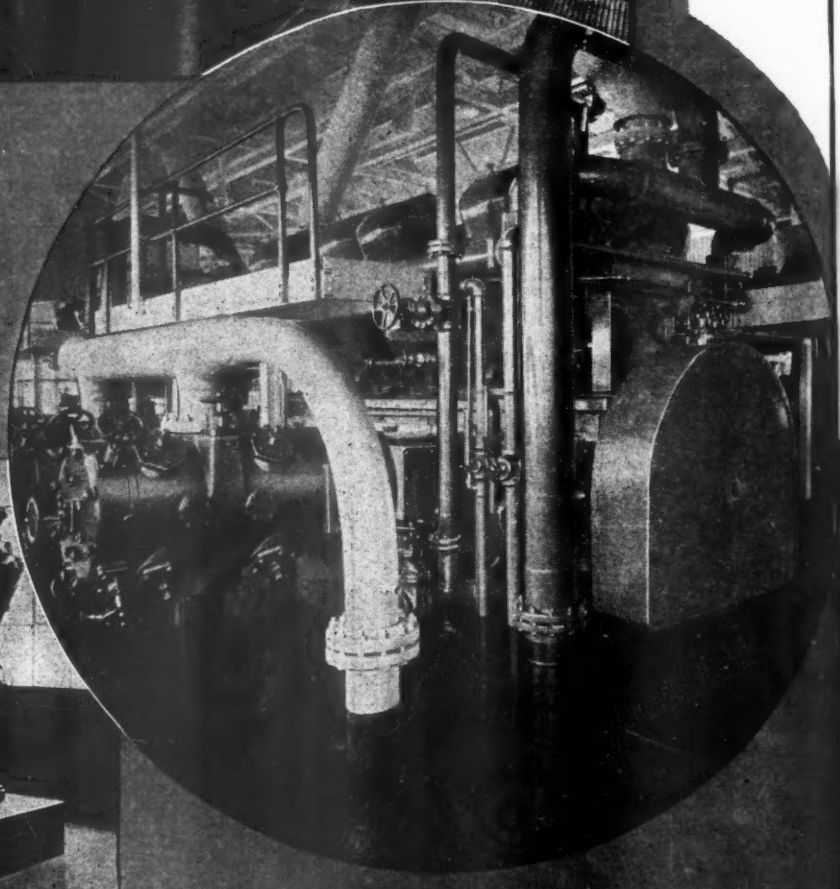
MORE AND MORE. 4-CYCLE Gas-

V-ANGLE DESIGN



(Above) General view of the compressor room, Hansford Station. Six of these units were installed in 1941, two in '42, four in '43, and two in '44.

In the Hansford Station of Panhandle Eastern Pipe Line Company, are fifteen 4-cycle V-angle units totaling 10,185 hp. This station is 100% I-R equipped (including all pumps and starting-air compressors) except for two generator units which were moved from the Liberal Station where they were replaced by the PVG engine-generator units shown on the opposite page.



(Above) Close-up of the new 800-hp KVG compressors at Hansford Station.

(Left) A 185-hp PVG gas engine in the Hansford Station.

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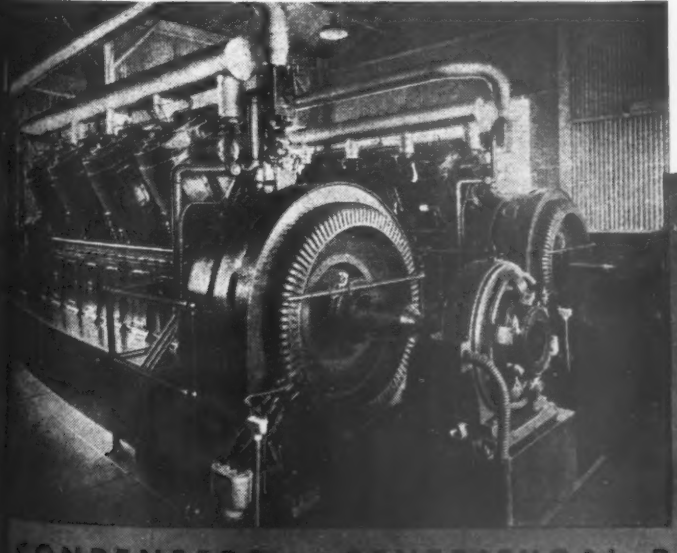
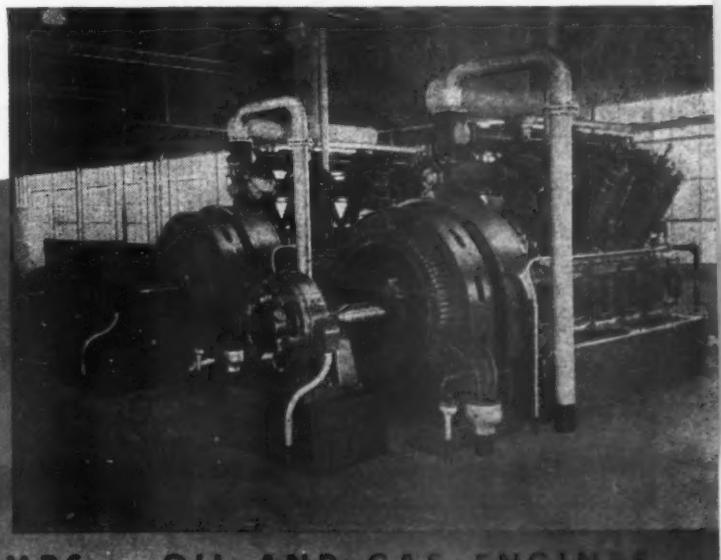


The first repeat order . . . two 275-hp gas engines installed at Tuscola in 1937.



CONDENSERS • CENTRIFUGAL PUMPS • OIL AND GAS ENGINES

(Continued from Page 179)

uct is pumped into a tank in sufficient quantity to raise the pressure in the vapor space to a point slightly above the relief valve setting.

This is best illustrated by means of a specific example using numerical values. These values were obtained from conclusive investigations conducted by several oil companies and represent the average of results obtained through tests on numerous tanks representing a wide range of capacities and covering a full scale of Reid vapor pressures. The tests were carried on north of the Ohio River and cover all the seasons of the year. All tanks were cone roof tanks equipped with the conventional pressure-vacuum relief valves.

Assume a cone roof tank having a capacity of 80,000 bbl., equipped with conservation vents. During the summer months the products stored are motor gasolines of an average R.v.p. of 9 lb. per sq. in., and during the winter months of not more than 12 lb. per sq. in. in R.v.p. The comparison between breathing and filling losses is as follows:

Breathing loss. These losses go on regardless of whether the tank remains as standing storage or whether it is emptied and filled several times a year. From the tests referred to, the value of this loss in per cent of tank capacity per year is 2.6 per cent. Therefore:

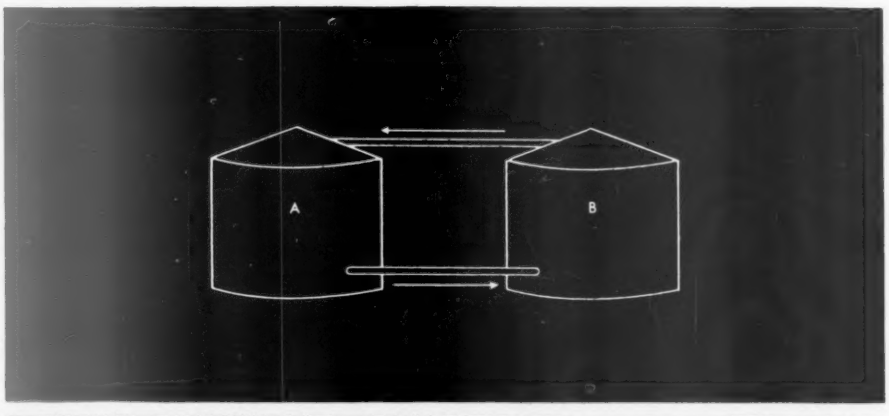
Breathing loss = 87,400 gal. per year.

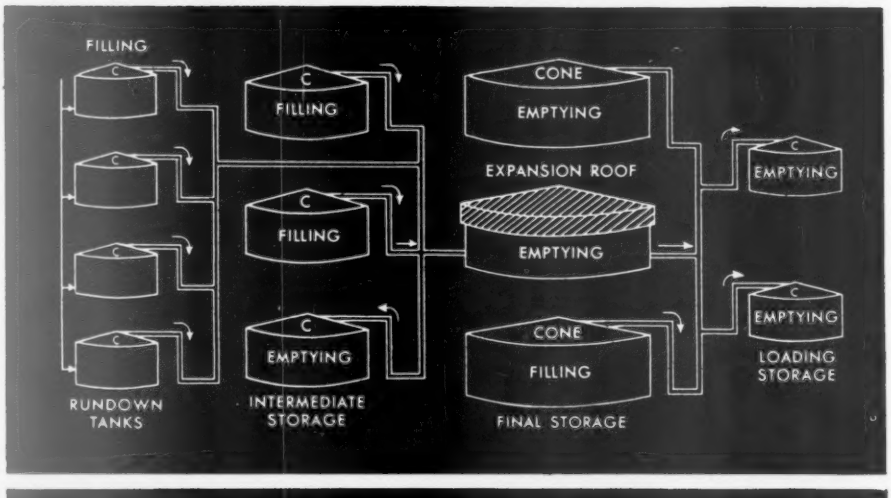
Filling loss. Using the same data, the value of the filling loss in rate of throughput is 0.00079 per cent. Therefore, the filling loss after each complete emptying and filling of the tanks is:

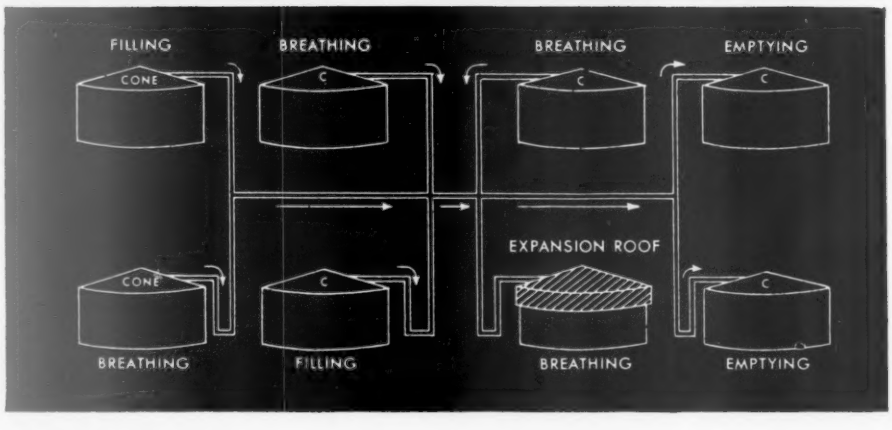
Filling loss = 2654 gal.

When the problem confronting the engineer consists of a single tank, the solution is fairly simple and does not offer great opportunity to test the engineer's competence and ingenuity. The usual evaporation problem at a pipe line terminal or refinery is not one of single units but involves several tanks that may or may not carry the same volatile product and, as is often the case, any proposed protective devices must include cone roof tanks that are already in existence. It is therefore of utmost importance to determine first the type and magnitude of the anticipated losses, secondly to choose the type of equipment best suited to eliminate that type and at the same time offer a reasonably quick return on the money invested, considering not only the original investment but also the cost of maintenance.

FIG. 1.







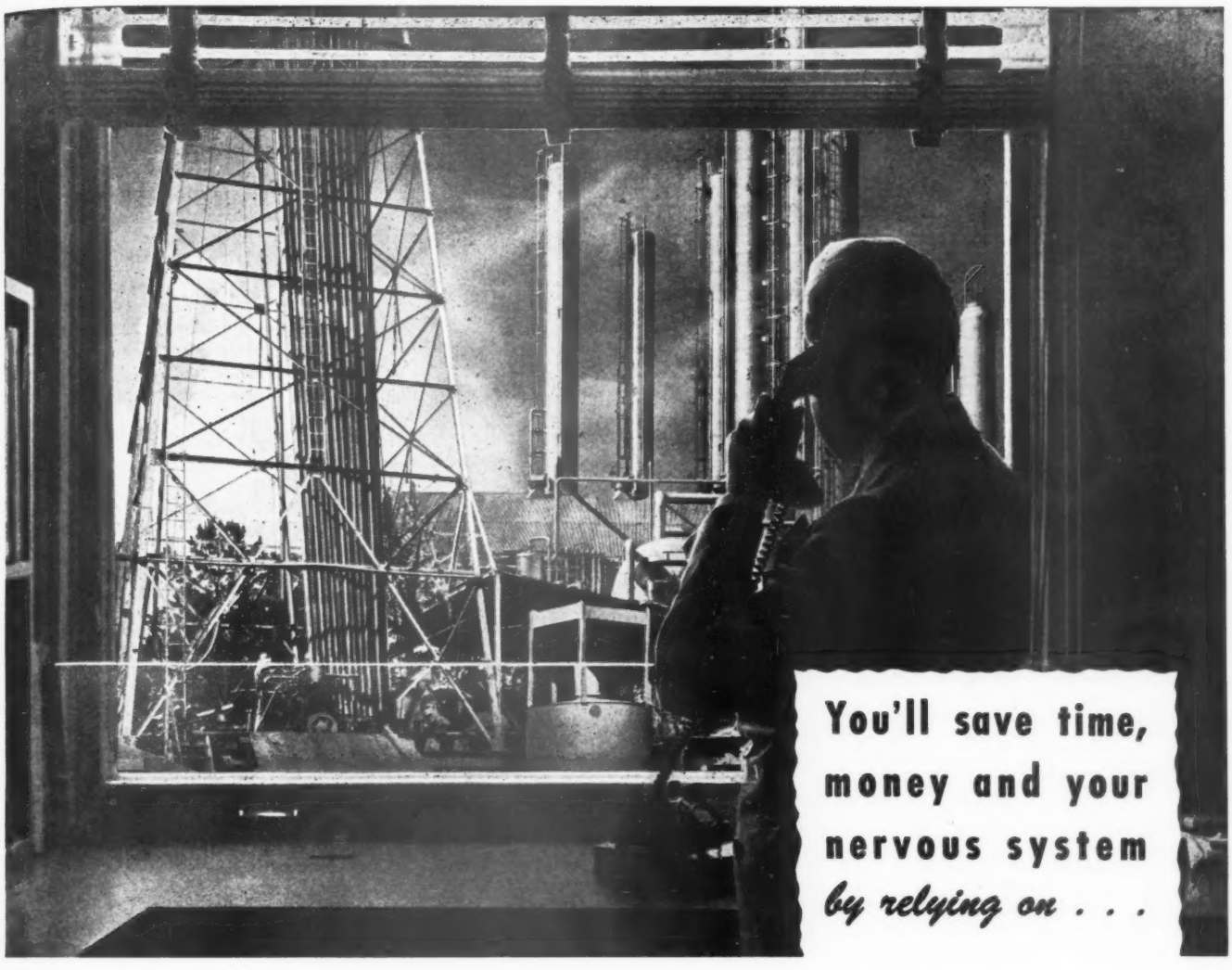
▸ **Eliminating breathing loss in single tanks.** Breathing losses from single units can be entirely eliminated by storing product in tanks equipped with variable space or expansion roofs. The variable vapor space in such tanks is to provide for the maximum expansion of vapors caused by daily changes in temperature. Expansion roof tanks operate on a principle similar to the common gas holder, which has been a familiar sight for many years, and the roof of this tank rises and descends with the expansion and contraction of vapors due to temperature variations. It is customary to design expansion roofs for the maximum expected expansion of vapors plus additional space to act as a gas reservoir during pumping operations. For capacities of expansion roofs with a "lift" of 5 ft. and of 10 ft., see Table 2.

▸ **Eliminating filling losses in single tanks.** A brief inspection of the comparative values of the breathing loss and filling loss used in the typical example for a tank of 80,000 bbl. capacity will indicate that under normal storage conditions, breathing losses are by far the most important factor in determining the economics of a proposed installation. It is evident, however, that under certain conditions of storage when a tank is subject to a rapid turnover, a point may be reached when the filling loss assumes primary importance. The number of complete turnovers in a given period determines whether the installation should be designed to give primary consideration to the filling or breathing loss.

Filling losses from single tanks may be efficiently eliminated by the use of a floating type roof. Such roofs rest directly on the liquid and operate on the principle that with the total or partial elimination of the vapor space, little or no filling loss can occur.

A study of the magnitude of both types of loss indicates that in order to justify the installation of equipment in single tanks primarily designed to eliminate filling losses, the number of complete tank turnovers per year must be, for the extreme tank sizes, more than 20 per year, and may be several hundred for the smaller sizes.

▸ **Eliminating breathing and filling losses in multiple tank installations.** Normally, the problem of protecting storage against evaporation losses involves more than one tank. In cases where the construction of new tanks is contemplated, there may be cone roof storage tanks already in existence and



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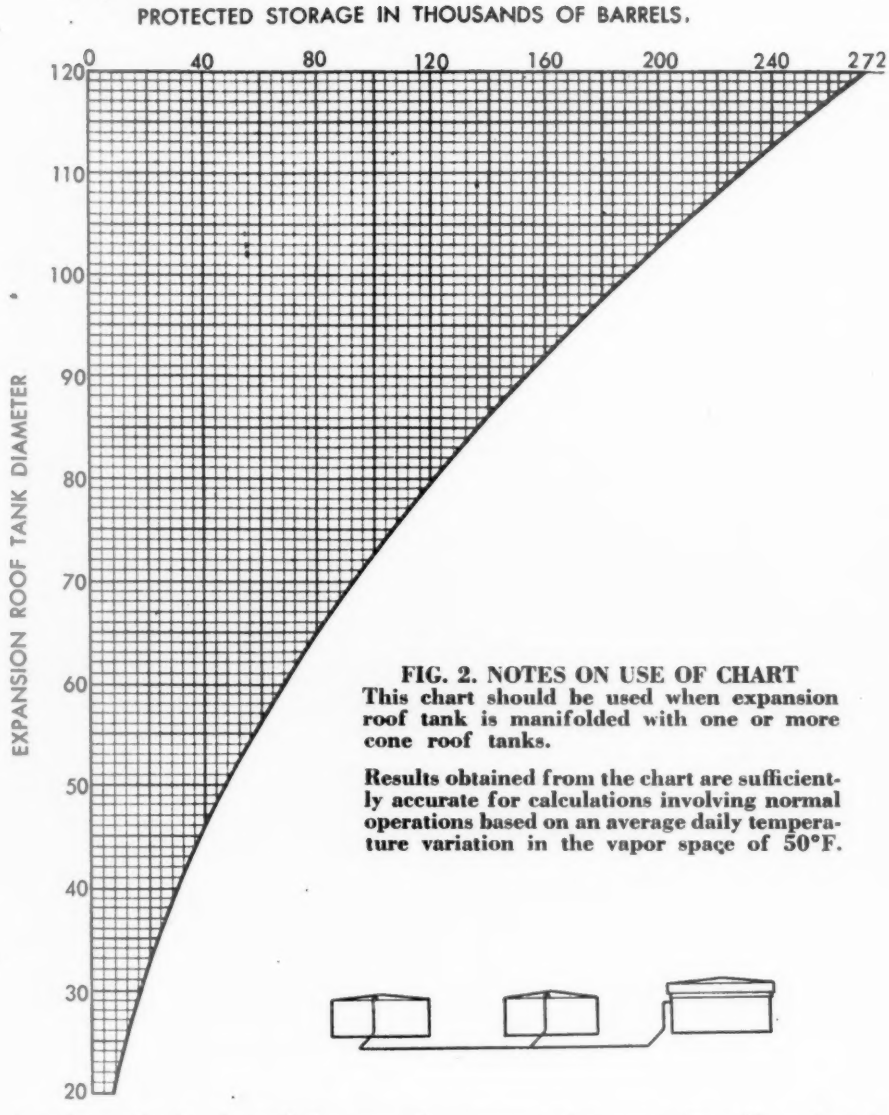

FIG. 2. NOTES ON USE OF CHART

This chart should be used when expansion roof tank is manifolded with one or more cone roof tanks.

Results obtained from the chart are sufficiently accurate for calculations involving normal operations based on an average daily temperature variation in the vapor space of 50°F.

it is here that by the judicious use of variable space or expansion roofs the maximum efficiency in eliminating all breathing and filling losses may be obtained most economically.

By connecting the vapor spaces of several cone roof tanks by means of vapor lines to the vapor space of one of the tanks equipped with an expansion type roof, the resulting closed system will permit the vapor to pass from one tank to the other when breathing or in the process of emptying or filling the tanks. The expansion roof then is not only designed to provide for the expansion of vapors in the entire system due to daily temperature increases, but acts as reservoir for vapors displaced in the tanks when total filling exceeds emptying.

It is evident that when tanks are manifolded in this manner, filling losses, in addition to breathing losses, can be eliminated without the necessity of installing expensive protective devices on each individual tank regardless of the number of tank turnovers involved. The basic principle involved is indicated by Fig. 1 and although its illustration may perhaps appear superfluous and elementary, it is often less fully understood when more than two tanks are involved.

Referring to Fig. 1, tanks A and B have their vapor spaces connected by means of a vapor line. If product is pumped from A to B, it will displace vapor at B, which will flow into A. Thus, if 1000 cu. ft. of gasoline is pumped from A to B, 1000 cu. ft. of vapor passes from B to A.

That this principle may be applied to eliminating filling losses at refineries or pipe line terminals is evident when we consider that the purpose of most tanks comprising a normal refinery unit or terminal installation is to provide temporary storage for products in transit to the final consumer and the total volume of products received in one day must of necessity very closely approximate the total volume shipped.

Such closed systems formed by manifolding tanks using an expansion roof as the "balancing" unit may be successfully employed to store a variety of products simultaneously and tanks containing sweet and sour crudes have been included in the same system without fear of contamination. Actual operations of closed systems prove that hydrocarbon gases are stable in the presence of their liquid phase and the air-vapor mixture found in the system. As the vapors in the vapor spaces of the cone roof tanks expand during the day, they flow through the vapor lines into the expansion roof, and the roof rises to provide for this expansion. During the night, as the temperature drops, these vapors flow back to the tanks and are reabsorbed by the product. The return of vapors to the tanks at night must not therefore be considered as a condensation occurring in the vapor lines but rather as a "shrinking" of the size of the saturated vapor space volume, and the vapor lines must be considered an "extension" of the vapor space in the tanks.

In taking advantage of the balancing effect of expansion roofs when manifolded to a battery of tanks, the engineer encounters a problem in design that has sufficient elasticity of solution to offer a real challenge to his ingenuity. The economical solution depends on several variables—the capacity or lift of the roof, the choice of tank on which it should be installed, the distance between tanks, which affects the size of the vapor lines and the valve settings, and the number of cone roof tanks to be included.

Returning briefly to the example illustrated by Fig. 1, it is seen that this principle may be applied to eliminate all filling losses in addition to the breathing losses, which are absorbed by the action of the roof. Crude oil tanks, run down, intermediate, and final storage tanks can be interconnected as a group, if one bears in mind that in terminal or refinery operations pumping out of product must be going on simultaneously with pumping in of product and that the additional expansion capacity provided in a properly designed expansion roof should be sufficient to act as a balancing reservoir to make up for the difference in pumping in and pumping out rates. The engineer should also be conscious of the magnitude of the losses involved. Thus it might be found expedient to ignore in certain instances small expected filling losses in the interest of economy.

Fig. 2 is here submitted as a guide in designing such systems as herein discussed and should be used only when a tank equipped with an expansion roof is connected with one or more tanks. Although this chart is based on roofs having 5-ft. lift, by increasing the height of lift, a proportionally greater storage can be protected. Thus from the chart a 100 ft. diam. roof with 5-ft. lift protects 94,000 bbl. of storage; a 10 ft. high roof would therefore protect 188,000 bbl.

Vapor conservation systems may also be designed employing other forms of gas reservoirs as the protective balancing unit, but in considering this type it must be remembered that such units cannot be used as storage tanks and must therefore utilize space that would otherwise be available for storage.

In choosing conservation equipment, particularly for low pressure storage, we must guard against a natural tendency to become static in our approach to the problem. The correct solution lies in giving the proper weight to the many variables involved. There is no type of equipment manufactured that will solve every possible problem; at the same time, no particular type should be condemned without thoroughly investigating its possibilities. ★★★

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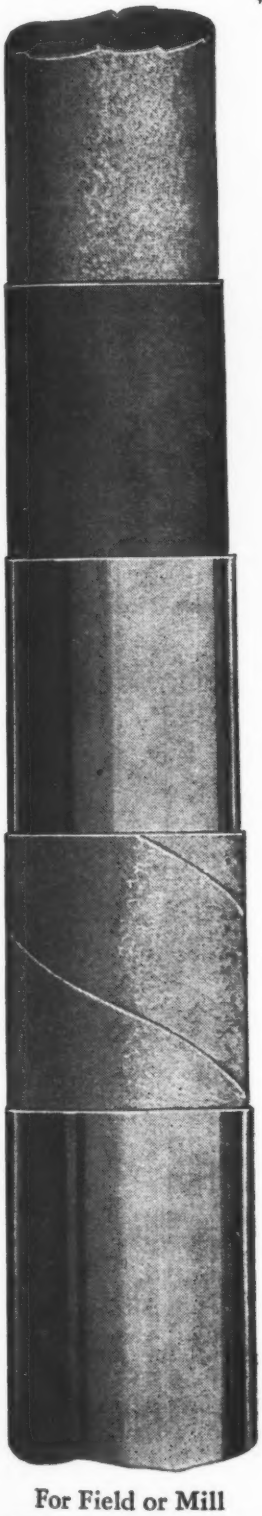

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RELATION OF WALL THICKNESS TO PIPE LIFE

By K. H. LOGAN*

EXCLUSIVE IMPROVEMENTS in the composition, quality, uniformity, and methods of fabrication of both steel and cast iron have resulted in stronger and more dependable pipes, making it possible to use lighter weight pipe with a resultant saving of material and costs. It is of interest to consider the relationship of this development to the life of underground pipe affected by corrosion. The bases of this article are data on corrosion phenomena published by the National Bureau of Standards and supported by those of other investigators, together with certain other data on costs and coating performance, both of which admittedly vary widely from place to place and from time to time. When the principles on which the article is based have been set forth the reader can substitute his own cost and other data and reach conclusions more suited to his local conditions. The corrosion phenomena upon which the article is based have been published previously and need only to be summarized here:

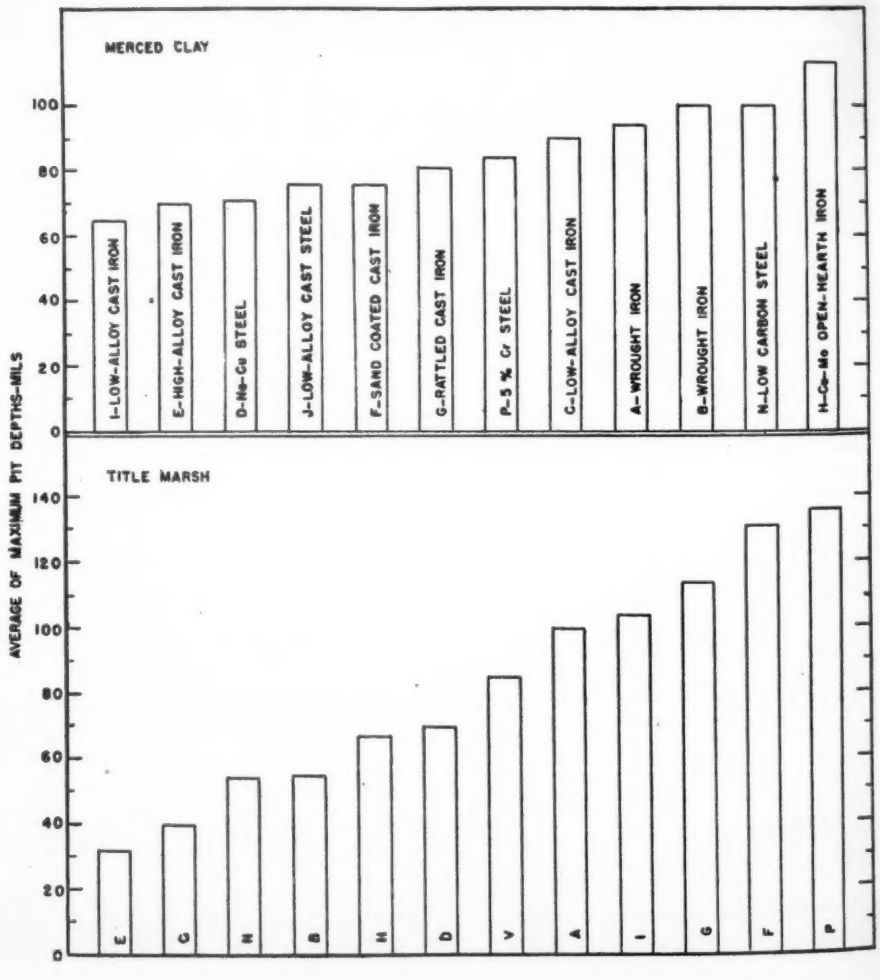
1. All ferrous materials commonly used underground corrode at nearly the same rate.[1, 2] (See Fig. 1.)
2. Soils differ widely in corrosiveness[3]. (See Fig. 2.)
3. The rate of pitting tends to decrease as the exposure is prolonged[3]. (See Fig. 3.)
4. The decline in the rate of pitting differs greatly under different soil conditions[3].
5. On the average the deepest pit on a large area will be deeper than that on a small area. As a corrollary, a leak may be expected to develop on a long line sooner than on a short one, other conditions being the same[3].

The relation of pipe wall thickness to the development of leaks. That corrosion will puncture a thin pipe wall sooner than it will puncture a thick one is scarcely debatable. The relative times required for puncture and the advisibility of using a thick or a thin pipe wall to avoid leaks is worthy of consideration because the relative merits of different wall thicknesses depend on soil conditions and on the cost of other methods of keeping the pipe in service, among which are soil treatment, coatings, and cathodic protection. There can be no single solution to the problem but a knowledge of corrosion phenomena and costs permits the choice of the best solution for a known soil condition.

Fig. 3 shows the maximum pit depth to be expected on 1000 ft. of 8-in. steel pipe after exposures to each of 7 soils for periods up to 98 years. The figure is based on pit depth measurements for steel pipe of various ages and on an equation representing the pit depth-area-time relation developed by Ewing[3]. For most soils Ewing's equation results in shallower pit depths in the later years than those computed from Scott's equation[3] for the pit depth-area relation. The standard deviations of constants used in both equations are large and the results are therefore approximations rather than accurate values. Nevertheless, the data are of considerable interest and value and they comprise the best data available at this time. The locations and characteristics of soils in Fig. 3 are shown in Table 1.

On Fig. 3 the wall thickness of various kinds of 8-in. steel and cast-iron pipe have been shown. The intersections of these wall thickness lines with the pit depth-time lines are the ages of the pipes at the time of the first puncture by corrosion. Consider first the muck soil. The figure shows that a leak can be expected in pipe having a wall thickness of 0.17 in., the thickness authorized by the Underwriters Laboratories for 8-in. steel supply lines, in about 3 years, whereas the pipe formerly specified by the American Petroleum Institute, which has a wall thickness of 0.32 in., will be punctured in about 6 years under the same soil conditions, i.e. the pit depths on pipe laid in muck soil are nearly proportional to the period of exposure. Even in muck, however, the corrosion decreases slightly, so that a pipe having a wall thickness of 0.6 in.—the wall thickness of 8-in. class D cast iron—will last 20 years or about 7 times as long as the light weight steel although it is only 3.5 times as thick. This is not because the class D pipe is cast but because it is thicker. Steel of the same thickness would last as long. Nevertheless, most users are not satisfied with a pipe that develops leaks in 20 years and some method of preventing such frequent leaks is usually adopted. At the other extreme is the Ruston series, well drained, sandy soils in which the light-

FIG. 1. Comparison of pit depths on ferrous materials. Specimens exposed to Merced clay adobe for 5 years at top; some materials exposed to tidal marsh for 9 years at bottom. Relative merit of the materials depends on the soil to which they are exposed.



*Research associate of the Cast Iron Pipe Research Association and chief of the underground corrosion section, National Bureau of Standards.

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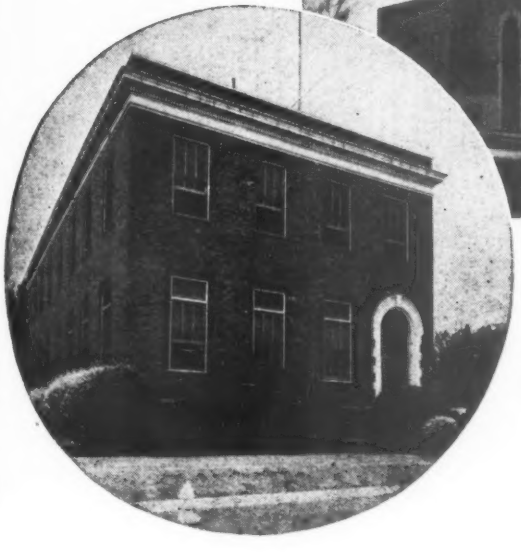

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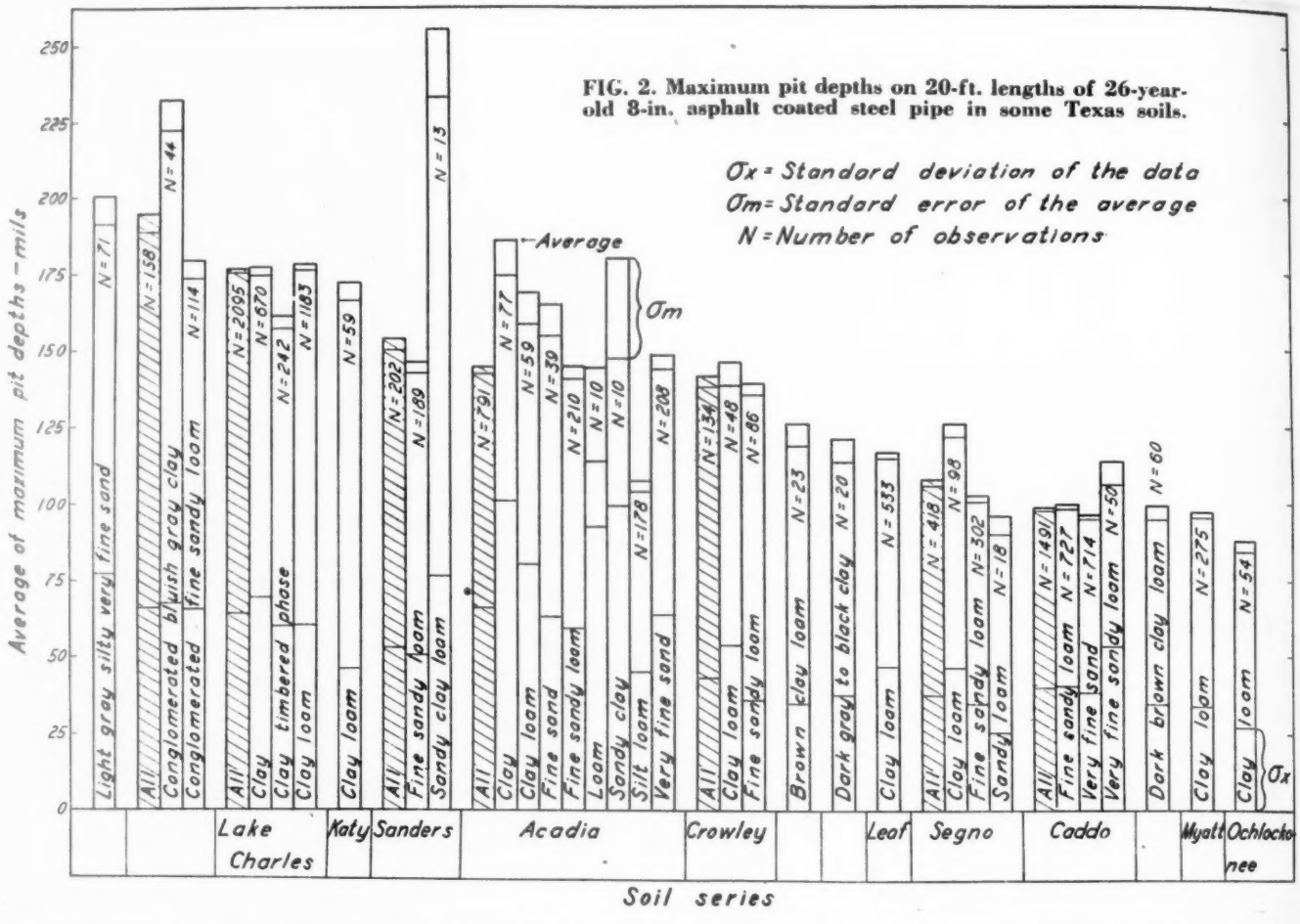


FIG. 2. Maximum pit depths on 20-ft. lengths of 26-year-old 8-in. asphalt coated steel pipe in some Texas soils.

est pipe that will sustain moderate water pressures will last indefinitely and in which no protection against corrosion is necessary. Slightly more corrosive is Bell clay, a moderately heavy and fairly well drained soil common in the vicinity of Dallas, Texas. In this soil the 8-in. pipe having a 0.17-in. wall thickness should last 20 years and a pipe with twice the wall thickness should serve more than 100 years before it is punctured by corrosion. In such a soil a little additional wall thickness greatly increases the serviceability of a pipe. Table 2 shows the effect of changes in pipe wall thickness on the time required for corrosion to puncture a pipe in Allis silt loam. It will be noted that the ratio of the change in puncture time to the change in wall thickness ranges from 2.7 to 4.7. This ratio is different for different soils, and increases as the thickness of the wall increases.

If a pipe line is to be laid in a corrosive soil the engineer may extend the life of the line by the use of: (1) A corrosion-resistant material; (2) a thicker pipe wall; (3) a protective coating; (4) cathodic protection, and (5) soil treatment. It is possible to combine two or more of these methods. The choice between the methods depends largely on the relative costs per year of life extension. Only in very corrosive soils and in cases where pipe failures involve large losses will the use of corrosion-resistant pipe be economical. Copper-molybdenum iron and wrought iron pit at nearly the same rate as steel in most soils.[4] Alloys high in chromium and nickel are very resistant to most soils[4] but are quite expensive. Copper, lead, and red brass are corrosion-resistant and may be economical for use under pavements if the pipe diameter is small, say 2 in. or less.

A common way of prolonging the life of a pipe is to cover it with a protective coating. The most commonly used coatings are coal-tar enamel or asphalt with or without a reinforcement or shield of cloth, rag, or asbestos felt. The Interstate Commerce Commission[5] fixed the life extension of pipe resulting from the

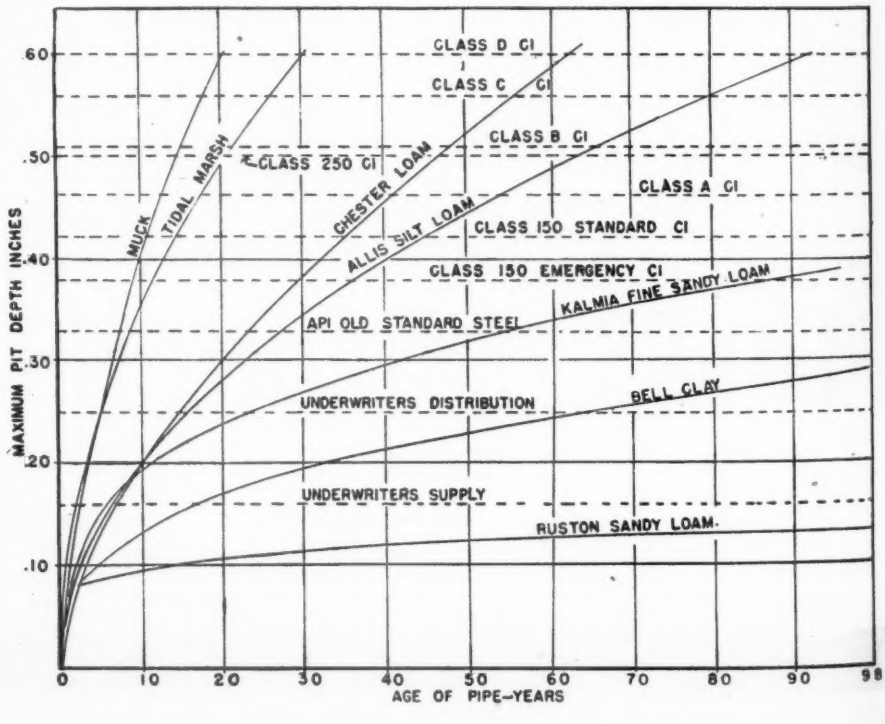
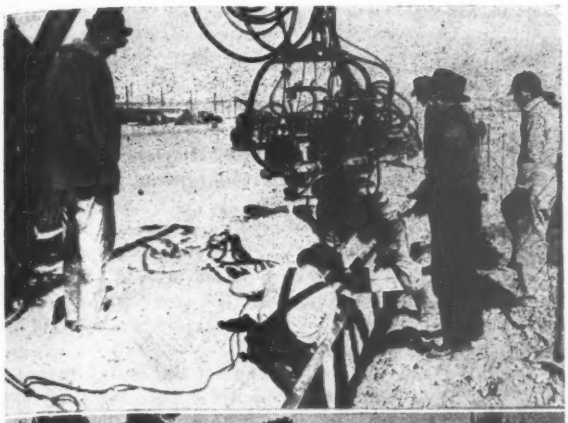
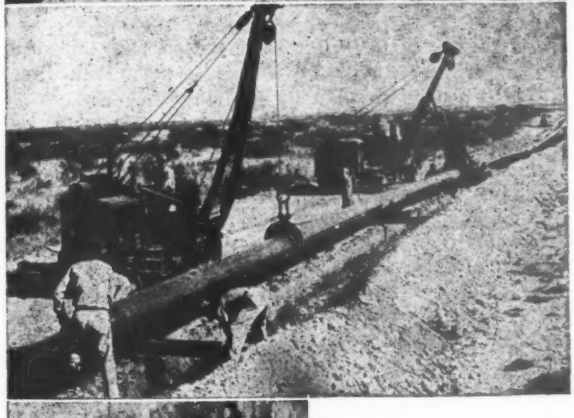


FIG. 3. Maximum pit depths to be expected on 1000 ft. of 8-in. pipe as indicated by Ewing's pit depth-area time equation.





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use of coatings as follows: Paint coating, 1 year; bituminous coating, 3 years; single-ply reinforced bituminous coating, 5 years; double-ply reinforced bitumen, 7 years; cement, 20 years. One list price of the reinforced coatings in 1930 was from $159 to $175 per 1000 ft. for single-wrapped coatings and from $240 to $263 per 1000 ft. for double-wrapped coatings applied to less than 20 miles of 8-in. pipe. In 1932 an oil company paid $218 per 1000 ft. for a coating consisting of 3 coats of bituminous enamel followed by a wrapper of asbestos felt and a flood coat of enamel. This indicates that the figures first quoted are in line with actual costs.

Table 3 shows the cost of increasing the thickness of 1000 ft. of 8-in. class 150 emergency alternate cast-iron pipe by substituting pipe of greater wall thickness, and the extension of the life of the pipe that may be expected as a result.

The data just presented permit a decision on whether it would be more profitable to apply a bituminous coating or use a thicker walled pipe. For example, to increase the life of 1000 ft. of class 150 emergency alternate cast-iron pipe 5 years by the use of a single reinforced coating would cost $159. According to Fig. 3 to accomplish the same life extension in a muck soil would require class 250 cast-iron pipe at an added cost of $150. If the pipe is laid in a tidal marsh, a pipe having the thickness of class A cast-iron pipe at an additional cost of $90 would give more additional service than this coating. In Chester soils $50 invested in more metal would accomplish as much as $159 invested in a coating. Similar comparisons can be made for the heavier coating and for thinner pipes.

The use of additional metal instead of some other method of increasing pipe life has its limitations. In muck soil a double wrap coating at a cost of $230 per 1000 ft. would, according to the assumptions of this article, prolong the life of cast-iron class 150 emergency pipe 7 years, accomplishing almost as much as a change to class C pipe at a cost of $270. Neither treatment would provide service for 25 years and a better solution would probably be the application of a cement coating that, according to the Interstate Commerce Commission, would add 20 years to the life of the pipe. Peper[6] gave the 1934 cost of cement coating applied to 8-in. pipe as from $60 to $350 per 1000 ft. depending on the method of application and the length of the line and local conditions. None of the estimates of coating costs include the additional cost of laying a coated pipe, which must be handled more carefully than a bare pipe if injuries to the coating are to be avoided. Another means of extending the life of a pipe is by the application of cathodic protection with or without a protective coating.

Rhodes[7] gives the cost of cathodic protection of bare 8-in. pipe over a period of 20 years by means of zinc anodes, a form of cathodic protection, as $290 per 1000 ft.

Finally the writer wishes to repeat his warning that the conclusions he has drawn are predicated on assumptions of costs of pipe and coatings and of pipe life extensions resulting from the use of thicker walled pipe or of coatings, all of which are functions of local conditions and some of which are only more or less intelligent guesses. The conclusions are, therefore, little more than speculations. They are, however, suggestive and perhaps they should be followed by attempts to get more specific data on which to base more reliable conclusions.

TABLE 1

Location and characteristics of soils shown in Fig. 3

Soil:	Muck
Locations:	Southeast, Great Lakes States and the Pacific Coast Region.
Characteristics:	Fairly well decomposed organic soil material, relatively high in mineral content, dark in color, and accumulated under conditions of imperfect drainage.
Soil:	Tidal marsh
Locations:	Atlantic and Gulf seacoast.
Characteristics:	Varies from dark, oozy sediments interspersed with coarse marsh grass roots to a yellowish or dark colored clay. Subsoil and water usually charged with hydrogen sulphide. Soil is always saturated with water.
Soil:	Allis
Locations:	New York and Ohio
Characteristics:	Subsoils are light colored and heavy. Surface drainage is good but artificial drainage usually necessary in subsoil.
Soil:	Bell
Location:	Alabama, Mississippi
Characteristics:	Dark, fairly well drained clay soil.
Soil:	Clay
Location:	Oklahoma and Texas.
Characteristics:	Usually calcareous. Sticky when wet, but crumbly and friable when dry.
Soil:	Chester
Location:	Pennsylvania, Maryland, Virginia, New Jersey, and Delaware.
Characteristics:	Subsoil is yellowish brown silty clay loam to clay loam of a friable, crumbly structure. Drainage usually good.
Soil:	Kalmia
Location:	Gulf Coastal Plains, region of Mississippi and Alabama.
Characteristics:	Yellow sandy clay subsoil of a creamy structure, poorly drained.
Soil:	Ruston
Location:	Alabama, Mississippi, Louisiana, Arkansas, and Georgia.
Characteristics:	Friable, reddish yellow or dull red sandy subsoils. Drainage usually good.

TABLE 2

Relation of pipe wall thickness to time required for the development of an average of one corrosion puncture per 1000 ft. of 8-in. pipe in Allis silt loam.

Class of pipe	Wall thickness in.	Time to puncture, years	Per cent increase in terms of: Next thinner pipe wall		8-in. supply pipe		Δlife
			thickness	life	thickness	life	Δthickness
Steel							
Supply	0.17	7					
Distribution	0.25	16	47	128	47	128	2.73
API	0.32	26	28	62	88	271	3.07
Cast Iron							
Class							
150	0.38	36	19	38	124	414	3.34
A	0.46	53	21	47	170	657	3.86
250	0.50	62	9	17	194	786	4.05
B	0.51	65	2	5	200	829	4.14
C	0.56	79	10	21	229	1029	4.49
D	0.60	91	7	15	253	1200	4.74

TABLE 3

Effect of increase of thickness of 8-in. cast-iron pipe (Class 150 emergency alternate is the basis for comparison)

	Class					
	150	A	250	B	C	D
Thickness, in.	0.04	0.08	0.12	0.13	0.18	0.22
Cost per 1000 ft., dollars	50	90	150	150	270	370

Soil	Life of Class 150 EA, years	Increase in years required for puncture					
Muck (acid)	9.5	1.5	3	5	5.5	8	10.5
Tidal marsh	11.0	3	6	9	10	14.5	18.5
Chester	29	5	11	16	17	26	33
Allis	35	9	17	27	29	44	56
Kalmia	88	11.6	28	..	..	..	..
Bell	100+	....	..	..	..	..	..
Ruston	100+	....	..	..	..	..	..

References

[1]J. C. Hudson, T. A. Banfield, and H. A. Holden, "Tests on The Corrosion of Buried Ferrous Metals." Iron and Steel Institute paper 6 (1942) (Great Britain).

[2]K. H. Logan, "Soil Corrosion Studies, 1934," *NBS J Research 16*, 431 (1936).

[3]K. H. Logan, "Engineering Significance of NBS Soil Corrosion Data," *NBS J Research 22*, 109, (1939).

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[5]Valuation Docket 1203, Atlantic Pipe Line Company, Interstate Commerce Commission Publication B 951 (1937).

[6]J. H. Peper, "Use of Cement in Protecting Underground Pipe Lines Against Corrosive Action of Soils," *Oil and Gas Journal 32*, No. 33, 9 (1934).

[7]G. I. Rhodes, "Two Unusual Installations of Cathodic Protection of Pipe Line," *Proc API 17* (IV) 21 (1936).

★ ★ ★

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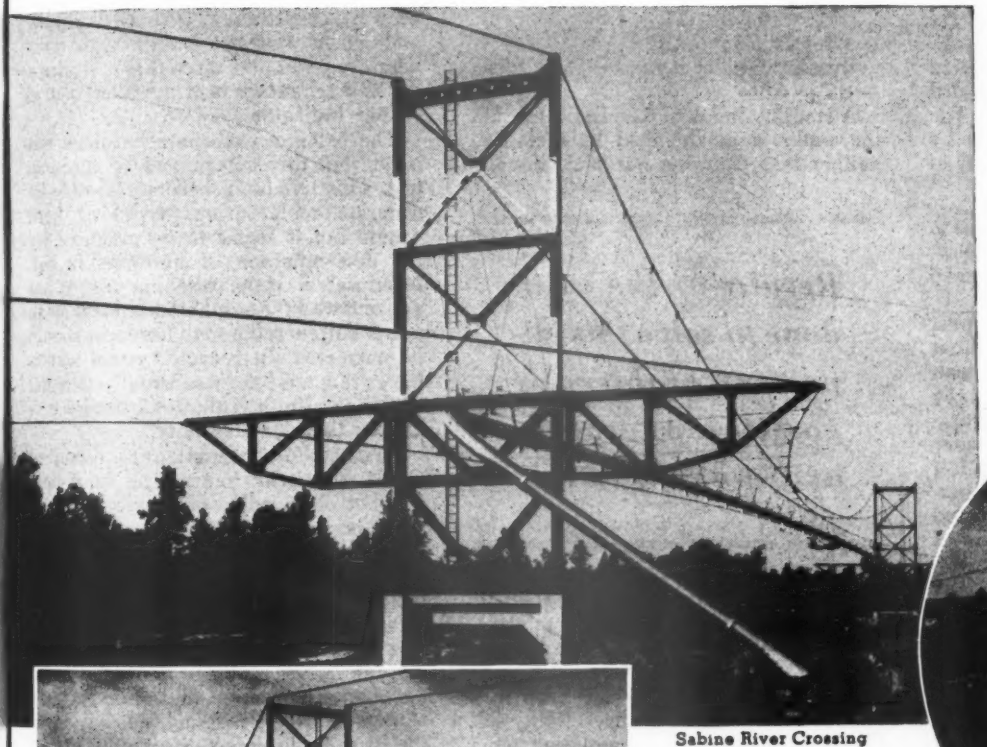

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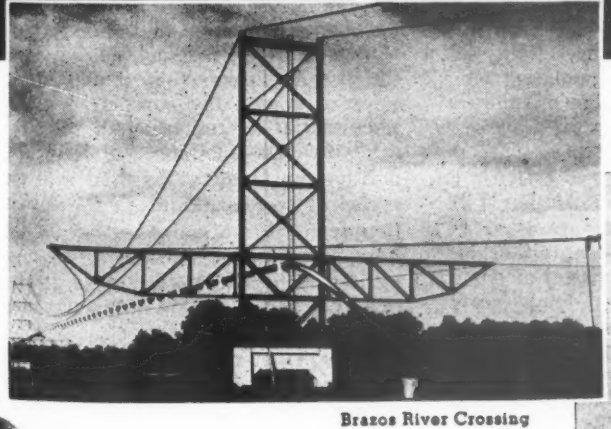

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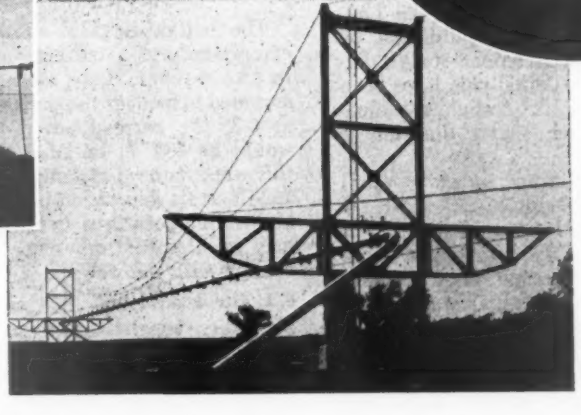

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P 624.5

CONTROL OF COMPRESSOR COOLING WATER

By E. G. HAMMERSCHMIDT, Chief Chemist
Texoma Natural Gas Company

EXCLUSIVE THE network of natural gas transmission lines throughout the nation requires that compressor stations be erected at reasonably regular intervals along the route. Each station requires some cooling medium for engine jackets and cooling coils, and, in most cases, the cooling medium is water. When the water supply is scarce it is necessary to conserve as much as possible by recycling the water until it becomes so concentrated by evaporation that it must be discarded in order to prevent scale deposition. The proper concentration is maintained by some method of blowdown, preferably of the continuous type.

▸ **Interpretation of analyses.** In order to determine the correct amount of blowdown in a system using softened make up water, the Ryznar[11] stability index has been of practical value during the past year at some 11 compressor stations that use the following types of softened water: Sodium zeolite, lime followed by sodium zeolite, lime-recycle, and hydrogen zeolite-sodium zeolite. The Ryznar stability index is calculated from a few simple chemical tests that may be performed by plant operating personnel who may not have had the benefit of technical training in chemistry. Interpretation of these tests may be obtained from Ryznar's modification of the Langelier[10] calcium carbonate saturation index. In the Langelier equation, pH_s is the pH at which a water of given calcium carbonate content is neither over nor undersaturated with calcium carbonate. The solution of the Langelier equation for pH_s requires a test of the water for the following: Alkalinity, calcium carbonate hardness, dissolved solids, and temperature. A nomograph of the Langelier formula has been published by Hoover[9]; also a convenient scalar diagram and a special slide rule have been described by Hirsch.[7, 8] A slight modification of the Hirsch scalar diagram is shown in Fig. 1.

The Ryznar stability index is equal to $2pH_s - pH_a$. In this equation, pH_s is the Langelier pH at saturation and it may be conveniently determined from Fig. 1; pH_a is the actual pH of the sample involved. As the Ryznar stability index falls below 6.3, the water becomes increasingly scale forming; between 6.3 and 7.0, the water is practically in chemical balance; above 7.0 the water dissolves scale and corrosion might result.

In order to use the Hirsch scalar diagram in Fig. 1, add 9.3 to the sum of the scale values opposite the total solids and temperature figures. From this subtract the sum of the scale values corresponding to the calcium and alkalinity. The remainder is pH_s. For example, consider the following recirculating system water:

Total (dissolved) solids	603 ppm
Soap hardness	18
Alkalinity	355
pH	8.7
Temperature, °F. . . .	100

$pH_s = (9.3 + 0.17 + 1.74) - (0.88 + 2.55) = 7.78$

Ryznar stability index $= (7.78 \times 2) - 8.7 = 6.86$

A stability index of 6.86 indicates that the water is in chemical balance, i.e., neither scale forming nor scale dissolving. The above calculations, applied in reverse order, can also be used to show the approximate temperature range within which this water will remain in chemical balance. Thus, when the scale dissolving side is reached, the stability index is 7.0, and the corresponding temperature correction would be as follows:

$$\left(\frac{7.0 + 8.7}{2}\right) + 2.55 + 0.88 - (9.3 + 0.17) = 1.81$$

The scalar diagram shows that 1.81 corresponds to a temperature of 93°F. In like manner, if the stability index is assumed to be near the scale-forming end at 6.3, the corresponding temperature would be 134°F. In other words, when this water is used at temperatures above 134°F, scale deposition is likely to occur and at temperatures below 93°F, scale may be dissolved wherever it comes in contact with the water.

Results of the work done to solve this important problem of gas line operation are made known.

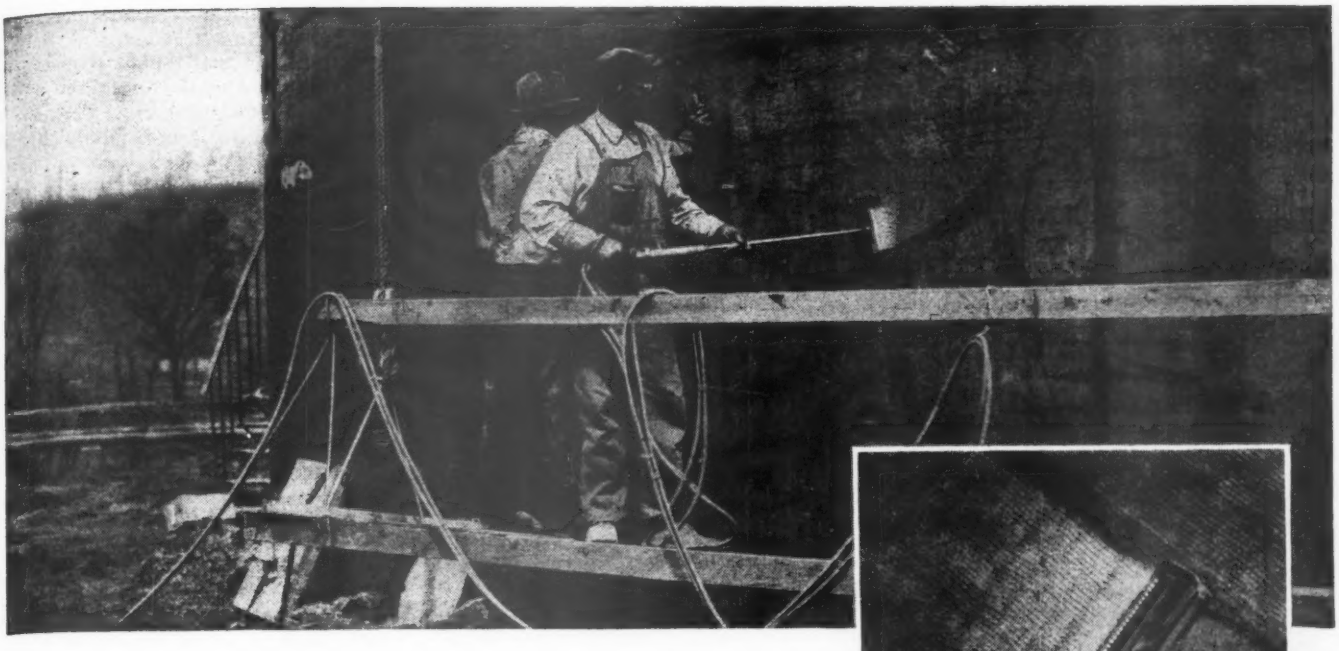
▸ **Control analyses.** The usual test for alkalinity consists of a titration with standard acid solution using methyl orange indicator. The color change of methyl orange indicator at the end point is rather difficult to detect because the change is from a color composed of much yellow and little red to one made up of less yellow and more red. An improved indicator has been described by Fleisher[6] who points out that the color changes that take place in the improved indicator are based upon a common principle. Methyl red indicator is yellow on the alkaline side and if a blue dye like alpha-zurine is present, a bright green color results. On the acid side, methyl red has a red color and in the presence of the same blue dye, a violet color is produced. The striking difference between violet and green and the intermediate gray near the end point gives this indicator a decided advantage over the usual methyl orange indicator.

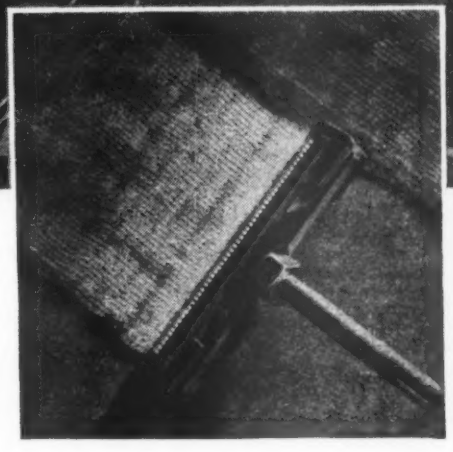
The calcium carbonate hardness test is conveniently determined by the soap test. This test often becomes grossly inaccurate with various types of hard waters but it seems to be practical for the determination of hardness in softened waters. If the softening process has not removed the sulphate hardness, as in a lime softener, the soap hardness should be corrected. In recycle system waters the carbonate hardness usually is equal to the alkalinity if the total hardness is greater than the alkalinity.[5]

A direct determination of dissolved solids is usually impractical in a field test but electrical conductivity methods have been described[2] and commercial apparatus of this type is available for plant control tests. Another indirect method for determining dissolved solids utilizes a simple chloride test in make-up and in system water. The ratio of chlorides in system water to the chlorides in make-up water gives the cycles of concentration of the system water. Then, if the dissolved solids content of make-up water is reasonably constant, a single gravimetric determination of dissolved solids in make-up water will serve as a multiplying factor to be used with the cycles of concentration. As the correction factor for dissolved solids in the Langelier formula is quite small in comparison with the other factors, a greater tolerance is permissible in this test than in any of the others.

For the determination of pH values with approximate accuracy in clear or slightly colored waters, the colorimetric comparators will be found much more economical in cost than the more accurate electrometric method.

▸ **Softening waters.** The discovery in 1934 that carbonaceous materials such as coal, when treated with concentrated sulphuric acid, were given base-exchange properties opened up a field of new materials with many interesting possibilities. These hydrogen exchangers are described and a list of literature references





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Since the steel is still warm from the oxy-acetylene flame when the paint is applied, the fluidity of the paint increases so that a better bond is obtained, and less paint is needed than for application on a cold surface. In addition, heat prolongs the life of the paint by giving it a low-temperature bake on the dehydrated surface.

The flame-priming process is easy to learn and easy to use, and requires only a small amount of equipment. For more complete information about flame-priming, get in touch with your nearest Linde representative. If you prefer, write for the booklet, "Flame-Priming," Form 5322A.

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on the same subject is reported by Broderick.[8]

When it became necessary to increase the capacity of the water softener at a field compressor station, the existing sodium exchanger was supplemented by a hydrogen exchanger that has been in operation since May, 1941. The softened make-up water at this station now consists of about 62 per cent from the hydrogen exchanger blended with 38 per cent from the sodium exchanger. The installation of the hydrogen exchanger at this station has resulted in a substantial saving in the required amount of make-up water. This is an important factor in economy where the raw water supply is costly. The following table shows the composition of typical make-up water from the hydrogen and sodium exchangers, together with the corresponding recycle system water that has been computed to the same Ryznar stability index in both cases. When the make-up water originates from the hydrogen exchanger blend, only 10 per cent of the make-up is required for blowdown, and when the make-up water originates from the sodium exchanger alone, 40 per cent blowdown is required.

	Make-up 62 per cent H_2Z and 38 per cent Na_2Z	Recycle system water	Make-up 100 per cent Na_2Z	Recycle system water
Total solids, ppm	135	1350	322	805
Alkalinity, ppm	22	220	182	455
Hardness, ppm	7	70	7	18
pH	7.1	8.0	8.0	8.2
Ryznar stability index at 100°F	12.6	7.0	8.9	7.0
Cycles of concentration	0	10.0	0	2.5
Per cent blowdown	0	10.0	0	40.0

At a main line compressor station, the raw water supply is quite high in dissolved carbon dioxide and it also contains some iron that precipitates on aeration. Both of these conditions are unfavorable to the operation of a sodium exchanger of the glauconite type. Consequently, when sodium exchangers were added to most of the station equipment a number of years ago, a lime softener was substituted at this particular station. It is a conventional softener with a precipitator, or chemical treating tank followed by sand filters. During the last 2½ years about 70 per cent of the water that passes through this softener has been recycled system water. This retreatment of system water has resulted in a reduction in blowdown that is equivalent to only one-third of the former blowdown requirements. The average blowdown requirement during 1944 was 32 per cent of make-up water. This is less blowdown than was required by any of the 7 stations that used sodium exchangers where the blowdown requirements ranged from 40 to 50 per cent of the make-up. In addition to this advantage, the system water at this station has become crystal clear because of its frequent passage through the sand filters. Clarification of the water has reduced the growth of organisms in the system water, thereby reducing the amount of chlorination required for slime and algae control.

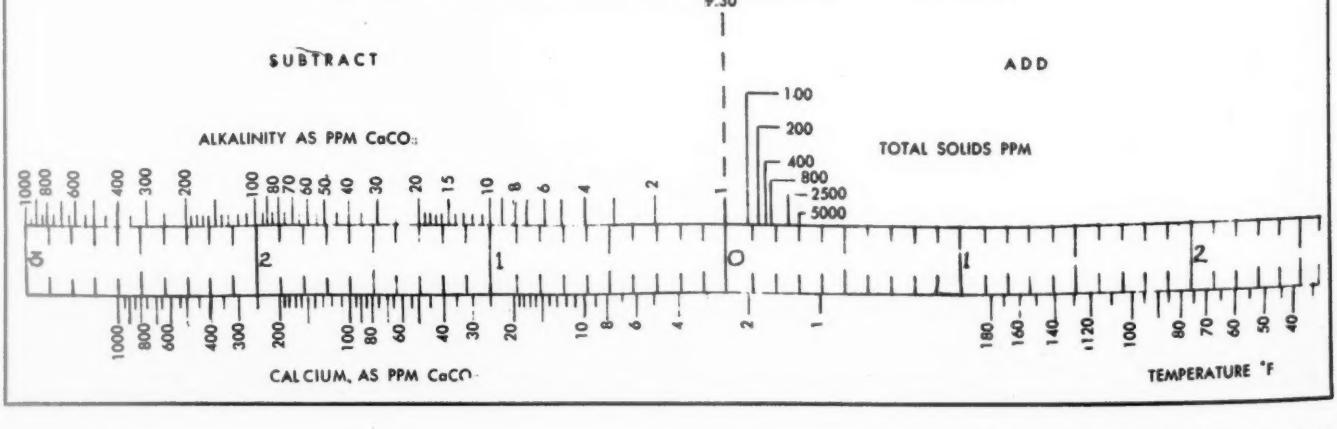
At another station the water is softened by means of a Spaulding precipitator[12] followed by recarbonation and filtration through a carbonaceous filter medium and thence through a sodium exchanger of carbonaceous zeolite. The Spaulding precipitator is a combination of mixing, coagulation, and settling tank designed to bring unstable lime treated water into equilibrium quickly by retaining the previously precipitated carbonates and the hydroxides in suspended contact with the water flowing through. The blowdown requirements in 1944 averaged 24 per cent of make-up water. This is almost as low as the blowdown at the station where the hydrogen exchanger is used.

Chlorination. Chlorine for slime control was adopted at all compressor stations several years ago. Infrequent and comparatively small doses are sufficient to control the slime at most of the main line stations. At the field station, however, slime accumulations have been much harder to control and prolonged periods of chlorine injection seem to be required. The heat load of the cooling tower is much greater at this station. It is likely that this condition combined with local climatic conditions is quite favorable for the abundant growth of algae and bacterial slimes. During the 2½-year period from June, 1942, to December, 1944, the average daily chlorine requirement amounted to 39.5 lb. per day. This requirement fluctuated widely with the season of the year, ranging from a high of 94 lb. per day in the summer to a low of 19 lb. per day in the spring. System water is circulated at a uniform rate of 5000 gal. per min.

An investigation of the use of chlorine and chloramine for slime control has been reported by Baker[3] who defines biological slime as a gelatinous mass caused by the growth of certain classes of bacteria in which fungi and algae may accumulate and grow so as to be even more objectionable than the initial bacterial slime; mixed with this accumulation there may be dirt or other foreign material. The results obtained from Baker's investigation, as they apply to the paper and pulp industry, show that: (a) the use of chlorine reduces slime difficulties but chlorine alone is not always adequate because of the rapid dissipation of its germicidal efficiency; (b) the application of ammonia with chlorine is beneficial because it prolongs the germicidal efficiency and reduces the tendency for corrosion, and (c) the cost of ammonia-chlorine treatment is about the same as chlorine alone. If these conclusions apply as well to compressor station system waters it would be desirable to adopt a chlorine-ammonia treatment in preference to chlorine alone. It was therefore decided to make a trial application of chlorine-ammonia at the field station.

Dissipation of germicidal efficiency. The dissipation of chlorine alone is quite rapid in compressor station system waters. In addition to the rapid rate of reaction of chlorine with organic matter, some loss probably occurs due to aeration and high temperatures at the top of the cooling towers. Chlorine and ammonia were added to system water in the ratio of 4 parts chlorine and 1 part ammonia. When the chlorine residual in the recycled water tested 0.1 ppm., the chlorine-ammonia feed was discontinued and 8 hours later there was still a trace of

DIAGRAM FOR pH OF CALCIUM CARBONATE SATURATION
Langelier formula—Larson-Buswell total solids-temperature adjustments.
(Adaptation from A. A. Hirsch diagram in J.A.W.W.A., May 1943.)



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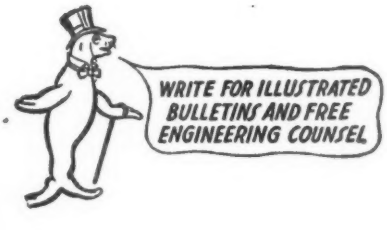

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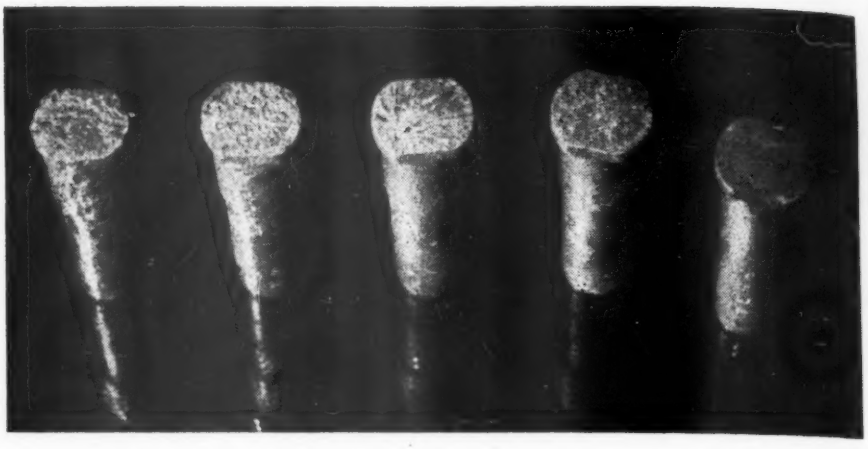
chlorine in system water. Under similar conditions where chlorine alone is used, the chlorine residual disappears within one-half hour after the chlorine supply has been shut off.

Corrosion tests. A series of corrosion tests were made with mild steel test coupons of cylindrical shape. The surface area of each coupon was 6.1 sq. in. Coupons were inserted in a modified sight feed lubricator and a side stream of system water was allowed to flow continuously and at constant rate through the apparatus.

The loss in weight method is a common method of measuring corrosion. Test coupons were cleaned, dried, and weighed. At the end of the test they were cleaned of corrosion products by immersion in a hot 2 per cent solution of ammonium citrate, and weighed again. A disadvantage of this method is that special types of attack are not measured. The loss in weight method has therefore been supplemented by the visual scoring method of Darrin[4]. This method is based on 5 factors that are rated as follows:

	Points
Discoloration or corrosion products:	
None	7.5
Slight	5.0
Moderate	2.5
Considerable	0
Roughening:	
None	10.0
Slight	7.5
Moderate	5.0
Considerable	0
Pitting:	
None	22.5
Slight	15.0
Moderate	7.5
Considerable	0
Depth of Pits:	
None	30.0
Shallow	22.5
Moderate	15.0
Deep	7.5
Very deep	0
General corrosion:	
None	30.0
Slight	22.5
Moderate	15.0
Considerable	7.5
Very bad	0

"General corrosion" includes the nature and distribution of the corrosion, the general impression of the observer, and unclassified factors. If no corrosion



1 2 3 4 5

CORROSION TEST COUPONS

1. Six-month test, compressor station, chlorine added.
2. Six-month test, gasoline plant, no chlorine added.
3. Fourteen-day test, compressor station system, chlorine added.
4. Fourteen-day test, compressor station system, chloramine added.
4. Fourteen-day test, compressor station system, no chlorine added.

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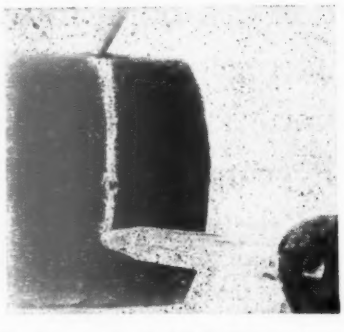

The above unretouched photo illustrates how a weld which appeared sound on visual inspection showed incomplete penetration when inspected by magnetic particle method.

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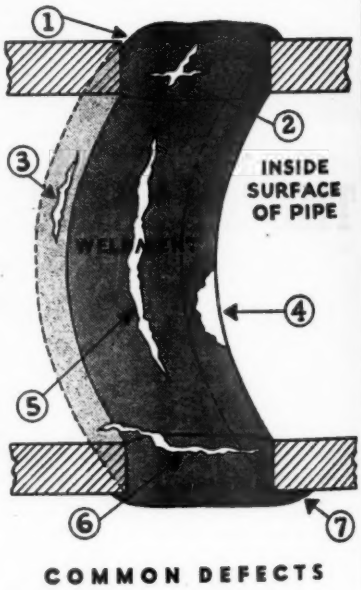

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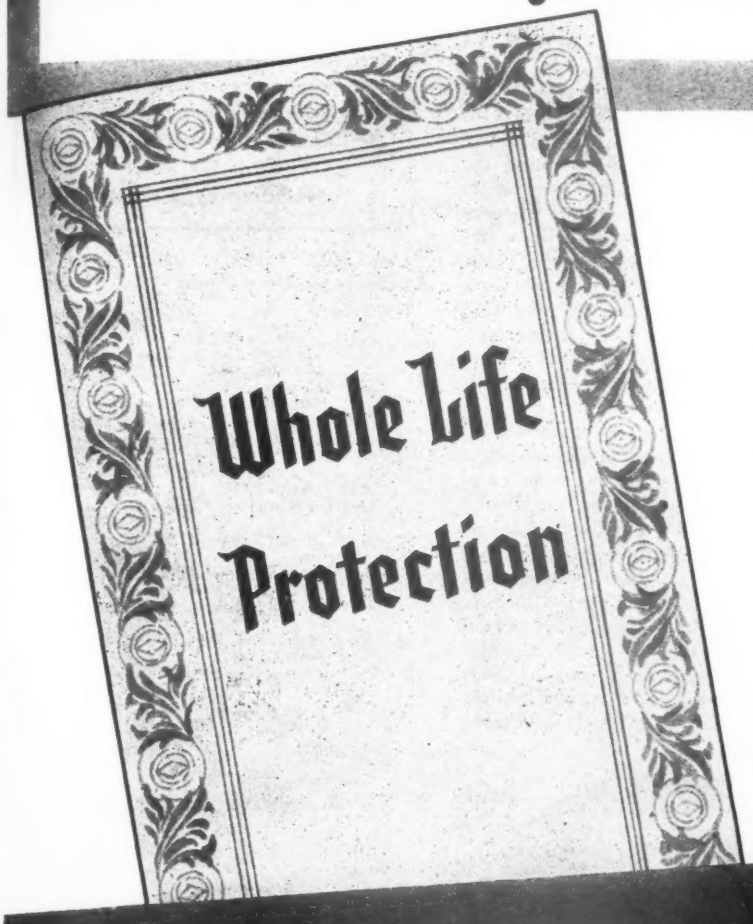

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occurs the visual score will indicate a maximum rating of 100.

One coupon was tested during the 14-day period, 11-3-44 to 11-17-44. During this time system water was continuously chlorinated, the residual chlorine ranging between 0.8 ppm. and 1.0 ppm. During the second 14-day test period from 11-17-44 to 12-1-44 the same quantity of chlorine was continuously added together with ammonia in the approximate proportion of 4 parts chlorine to 1 part ammonia. During the third 14-day test period from 12-4-44 to 12-18-44 no chlorine or ammonia were added. The results indicate that system water is less corrosive in the presence of chloramine than in the case of chlorine alone, and that system water is less corrosive when neither chlorine nor chloramine is present in the concentration mentioned above. (Table 1.)

TABLE 1

	Weight loss, mg per sq. in. per day	Visual score
14-day test, compressor station system, no chlorination	2.9	64
14-day test, compressor station system, chloramine added	6.4	57
14-day test, compressor station system, chlorine added	8.5	36
40-day test, main line station, no chlorination	2.4	43
40-day test, main line station, chlorine added	4.2	23
6-month test, gasoline plant system, no chlorination	2.5	23
6-month test, compressor station system, chlorine added	4.1	15

Consecutive corrosion tests of 40 days' duration were made at a main line station in the manner described above and the results confirm the data of the 14-day tests (Table 1).

A 6-month field station corrosion test was made simultaneously in the gasoline plant system water and in the compressor station system water. Gasoline plant system water overflows and serves as make-up to the compressor station system water. During the corrosion test period, the gasoline plant system water was not chlorinated and the compressor station system water was chlorinated. The Ryznar stability index showed the gasoline plant system water to be scale dissolving (corrosive tendency) whereas the compressor station system water ranged between a balanced and a scale-forming condition (non-corrosive tendency). Despite this, greater corrosion occurred in the compressor station system water. These results (Table 1) again show that chlorination increases the corrosive tendency of a water.

Cost of chlorine vs. chloramine. Insufficient data have been accumulated to make a cost comparison between chlorine and chloramine. During the 39-day period from 7-22-44 to 9-8-44, chlorine was consumed at the rate of 87.5 lb. per day. Ammonia and chlorine was used during a following 8-day period in September and also during an 18-day period in December, at the rate of 53 lb. chlorine per day. This seems to indicate that the use of ammonia reduces the chlorine consumption; however, local conditions may have varied during these three periods of observation.

QUOTS

"The overall result of the recent expansion of oil pipe lines is a sizable permanent addition to the country's transportation facilities. All these lines, particularly the Big Inch and Little Inch, have contributed greatly to the solution of the oil transportation problem during the war emergency. All but six of the new lines are privately owned and operated and nearly all will continue in operation after the war."—*Sam G. Spal, The Interstate Commerce Commission.*

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ELECTRICAL EQUIPMENT ON LITTLE BIG INCH LINE HAS AUTOMATIC AND SAFETY FEATURES

By **A. S. MUNNEKE*** and **JACK L. GATES†**

EXCLUSIVE MUCH has been written about the "Big Inch" pipe line, the difficulties encountered in construction, and its successful completion, but considerably less is probably known by the general public concerning its companion, the "Little Big Inch."

The "Little Big Inch" is a 20-in. products line beginning at Beaumont, Texas, and extending to the New York area, a total of 1475 miles. The push behind the products in this line is given by 28 pumping stations, spaced approximately 50 miles apart, with a total electric motor capacity of approximately 113,500 hp. In general, each pumping station consists of three units, operating in series, each unit being composed of one 1250 hp. induction motor driving a centrifugal pump. There is, of course, much more to a pumping station than pumps and motors, and that is the part with which we wish to concern ourselves in this article.

Suppose we take an imaginary trip to one of these typical stations. We have heard of the "bigness" of all this equipment and the enormous capacity of the line, therefore, as we drive toward the station we naturally expect to see a large pump house and possibly a large substation structure similar to what we are accustomed to seeing around public service centers. We are surprised when we drive in view and see a small neat pump house, approximately 36 ft. by 80 ft. with 10 ft. walls. As we are concerned primarily with the electrical installation, let us begin with what is first seen—the incoming power line.

The primary voltage of the power line may vary from 22 kv. to 110 kv., depending on which of the 17 power companies serves this particular station; secondary voltage in all cases is 2400. This transmission line may be a few hundred feet long from where it taps the main line of the power company, or again it may be miles long. In one case it was necessary to build more than 100 miles of overhead transmission line to reach the remotely situated station, for the station locations were rigidly fixed by the hydraulics of the line and could not be altered for the convenience of existing power facilities.

We are all accustomed to seeing substations as a mass of steel work, overhead busses, large insulators, enormous oil circuit breakers, and other equipment. In this case we are surprised to see a few wooden poles and a single transformer. The substation consists of one 3750-kva. 3-phase oil-insulated self-cooled transformer equipped for future air blast, which would give a rating of 5000 kva. Various combinations of voltage taps above and below normal voltage are provided, the exact number and percentage being determined by the power system stability. This transformer is protected on the primary side with a set of disconnecting fuses, ahead of which is installed an air break isolating switch. A 4-pole structure is situated on the secondary side of the power transformer, between the transformer and pump station, and serves the purpose of supporting the 1200-amp. gang-operated disconnecting switch and transformers for auxiliary power and lighting. This auxiliary equipment consists of three 10-kva. single-phase transformers, connected delta delta, 240 volt secondary, for power, and one 15 kva. single-phase 120/240 volt secondary for lighting. This transformer bank is protected with conventional fuse cutouts on the primary side.

From the abovementioned structure the main feeder lines go into the control room through porcelain wall bushings, and thence to bushings on top of the main metal clad switchgear. The switchgear, control desk, sequence control cabinet, teletype machine, and other equipment necessary to the operation of the line are in a control room at one end of the pump house. As it is possible that a gaseous atmosphere may exist in the pump room and around the manifold area, the control room is sealed as tightly as possible. As a further precaution a supply of clean air from the outside is forced into the control room, thus maintaining slightly higher than atmospheric pressure. With this arrangement it is assured there will be no accumulation of gaseous vapors in the control room and conventional switchgear and other equipment can be used. All conduit and piping entrances into this room are installed with stuffingboxes.

The factory assembled metal clad switchgear is of the lift type, both for full and reduced voltage starting, depending on the requirements of the power company serving the particular station. In all cases the switchgear consists of an incoming line breaker, 1200 amp. 100,000 kva. interrupting capacity, and the motor starting breakers are in general rated at 600 amp. This switchgear is essentially standard metal clad, equipped with undervoltage, overcurrent and reverse phase relays, watt-hour meter, recording voltmeter, and other standard accessories. Slight changes were made to accommodate the protective and automatic features, which will be described.

Before leaving the switch room, let us examine the "heart" of this electrical control system. The sequence control cabinet is truly a "heart," as all protective devices lead to this point, and from here is given the "order" regarding what

PUMPS

*A. S. Munneke, an electrical engineer with Stanolind Pipe Line Company, Tulsa, Oklahoma, was loaned to War Emergency Pipelines, Inc., for the 24-in. and 20-in. pipe line construction. A graduate of Oklahoma University, Munneke was with Southwestern Bell Telephone Company five years and joined Stanolind in 1937.

†Jack L. Gates was loaned to War Emergency Pipelines, Inc., by Standard Oil Company (N. J.) He spent 10 years in the Aruba N.W.I. refinery of his company, experience that helped him with PAW in the foreign refinery division, which he joined when his work was finished with WEP. Four months ago he joined General Foods Corporation.

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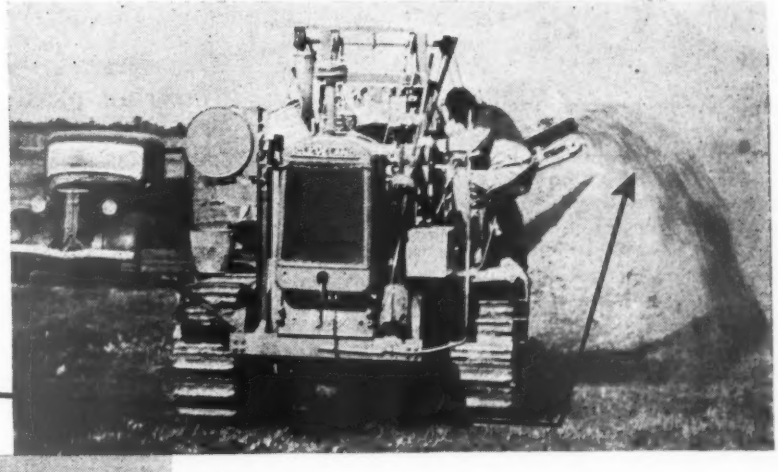

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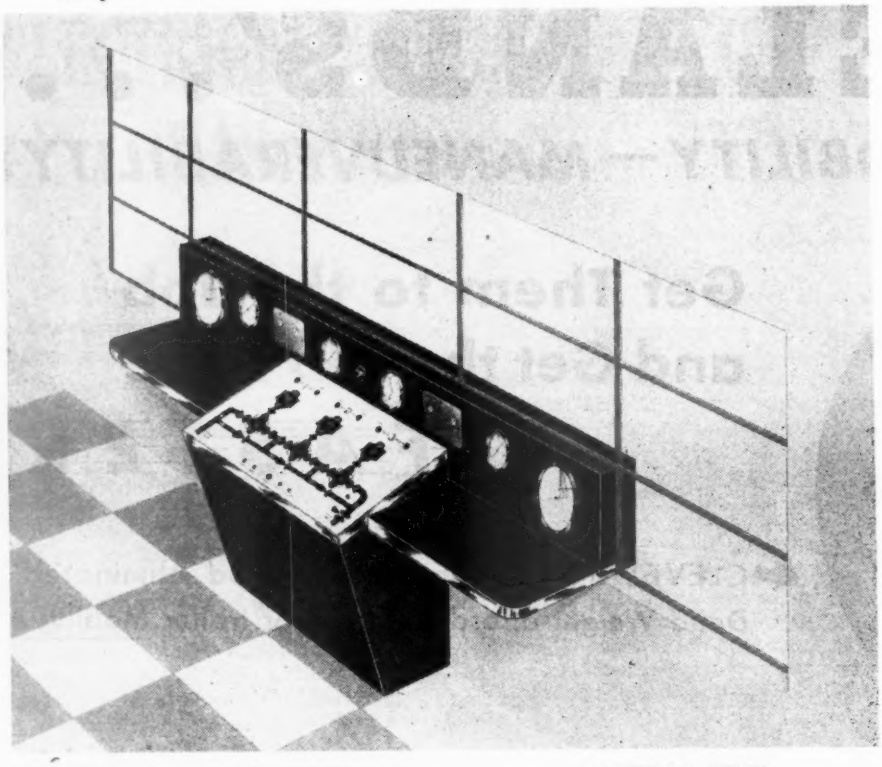


CONTROL DESK

steps are necessary to protect this valuable equipment.

In the same room is a beautiful piece of furniture, which on closer inspection proves to be quite an unusual desk. Laid out on this desk top is a schematic diagram showing the piping and all valves pertaining directly to the station, as well as to the pumps and motors. Arrows are spaced along this piping diagram that show the direction of flow of the oil through the line. Spaced at different points on the motors, pumps, and valve are small indicating lights, each of which performs a very definite duty. By glancing at them the operator can tell which valves are open, which closed, and when any protective device is actuated, the corresponding indicating light is illuminated, telling the operator the location and nature of the trouble.

A gage board is mounted above this desk, which contains the pressure controllers, pressure gages, flow meter, air regulating valve, and a clock. This gage board is in reality a metal box that extends through the fire wall into the pump room, the front part being completely vapor tight. All piping enters from the pump room side and is accessible from the pump room side only. Around the control board, extending upward about 2 ft. and several feet on either side of the firewall, is a glassed-in portion of the wall. This allows the operator a clear view of the pump room without leaving his post at the desk. This control room is provided with an electric circulating air heater. Also in the room are the power distribution panel and lighting panel.

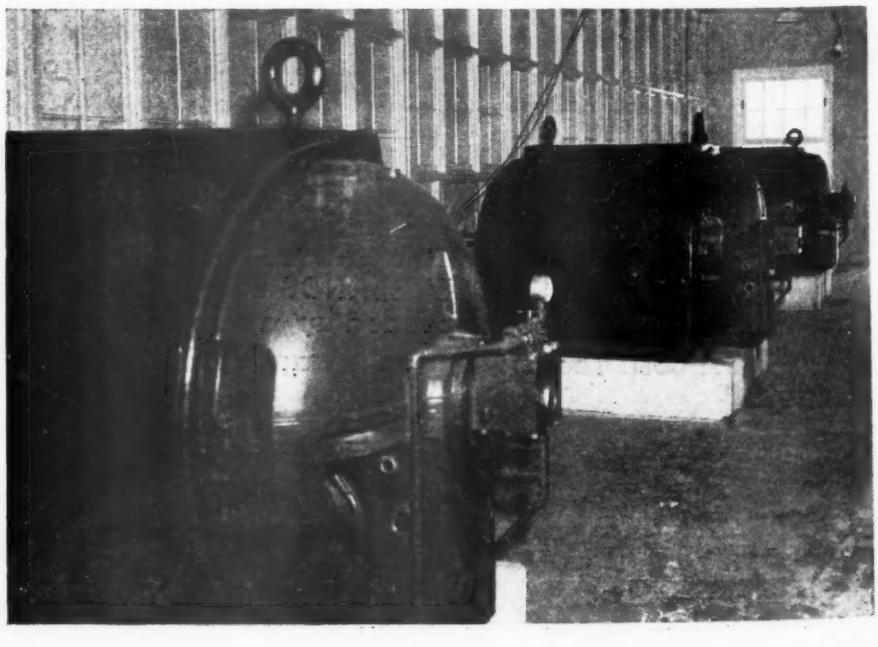
In the motor room are the three 1250-hp. 2400-volt 3-phase 3600-r.p.m. induction motors. Each motor has an extended shaft that passes through a stuffingbox into the pump room where connection is made to the centrifugal pump. Although these motors were supplied by several manufacturers, the mounting dimensions were standardized to insure interchangeability regardless of manufacturer. A duct with attached hood is mounted over each motor and is equipped with a small suction fan that draws the heated air away from the motor. This air in the summer is ejected through roof ventilators, but for cold weather provision is made to distribute the warm air through flame arresters into the pump room for heating purposes.

Incorporated into the motor room is a wash room for the convenience of the operators, and an air compressor that supplies the necessary air to operate the pneumatic pressure regulating valve in the station discharge line. A steel rack, placed along one wall, contains a number of temperature devices. These devices are connected to the motor bearings with capillary tubes and then wired through conduit back to the sequence control cabinet. If the bearing temperature rises above a safe point, this temperature device automatically trips the circuit breaker, sounds an alarm, and illuminates the proper indicating light on the control desk. The motors are also equipped with a winding temperature device. If the motor winding temperature becomes abnormal, this device sounds an alarm and again the proper light on the control desk is lighted, indicating the exact point of the trouble. It was considered advisable not to have this device take the unit off the line, as in most cases the operator could control the temperature by reducing the load or by some other means, and thus avoid an unnecessary shut down. The operator has been warned, however, that something is wrong and must take the proper steps to eliminate the trouble.

A similar group of instruments are placed in the pump room, which include a number of so-called "station devices." Each pump is equipped with bearing and casing temperature devices. These operate in exactly the same manner as those previously discussed for the motors. The station devices are so called because they affect the station as a whole rather than any particular unit. These station devices consist of: Low suction pressure, high sump case pressure, high discharge pressure, and low air pressure.

The low station suction pressure device is so arranged that the incoming line circuit breaker is "locked out" unless there is sufficient suction pressure from the station below to allow safe starting of the centrifugal pumps. It will also trip the aforementioned breaker if the suction pressure should fail for any reason. As well as performing these tripping and lockout functions, this device sounds an alarm and lights the proper indicating

MOTORS



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light on the control board.

The high line pressure device takes the station off the line immediately in case of abnormal pressure on the discharge line in the same manner as the low station suction device.

The high pump pressure device, although only one device, actually ties in on each pump unit, performs the alarm and light functions, and in addition is equipped with a series of relays that operate in the following manner: If the three units are operating in series (which is normal operating sequence) and for some reason the pressure increases above a predetermined value on the discharge of No. 3 unit, that unit is immediately taken off the line. When this happens, a relay is actuated in the trip circuit of No. 2 unit, which will function within a matter of seconds, possibly two to three depending on what operating conditions dictate, and as No. 2 unit trips the same procedure follows for No. 1. If at any time during this operation the pressure decreases, these relays are taken out of the circuit and go back to normal operation; however, the operator must restart any unit that has been taken off the line by abnormal pressure.

As proper operation of the regulating valve in the discharge line depends on an adequate supply of air from the air compressor, there is installed a pressure device that will sound an alarm and light an indicating light if this pressure fails.

Suction and discharge valves on these pumps are motor operated, and the limit switches are tied in with the control scheme in such a manner that there are several unusual safety features.

Perhaps a better understanding may be had of the functions of these devices if the necessary steps of an actual start are described. Suppose the operator has received an order to put his station on the line, and has made necessary valve settings and has the required suction pressure. He then goes to the control desk and at the top are push buttons designated "start" and "stop," which are the controls for use in normal operation. He presses the "start" button, which has no other function than closing the contactor on the suction valve. The suction valve begins to open and during its travel both a green and amber light appear on the symbol of the schematic diagram. Both lights being lighted indicate that the valve is operating. When the valve reaches the fully open position, the green light is extinguished—only the amber remaining lighted. At this point, time limit switches operate, one of which is in the control circuit of the switchgear circuit breaker. (We are now considering reduced voltage starting). When this limit switch operates, the starting breaker is closed. When the transition is completed from starting at reduced voltage and the running breaker closes, a circuit to the discharge valve is set up and this valve begins to open. In this way there is no load placed on the motor until it has reached full speed. The discharge valve then continues to open (of course the suction valve circuit has been deenergized) and as in the case of the suction valve both the green and amber lights are lighted. When this valve reaches its fully open position, the green light is extinguished and the pumping unit is on the line; however, we have not finished with the limit switches on these valves. They are so arranged that if for any reason (because of defective wiring, etc.) the suction valve should leave its open position, the circuit breaker for this unit would be tripped immediately. This would avoid any possibility of the pump operating without adequate suction pressure.

The above procedure is followed in putting No. 2 and No. 3 units on the line. In other words, the operator pushes one button; from there on the sequence control scheme takes charge and the unit is automatically put into operation. If the operator should push the "start" button and then change his mind, he may push the "stop" button. The valves will automatically close, and all devices will reset ready for a new start.

Assume now that all three units are operating in a normal manner and consider what happens should a few possible sources of trouble develop. Suppose for instance the outboard bearing in No. 1 pump should become overheated. At this point the temperature device takes charge. As this device operates, three contacts are closed, one being connected in series with a red indicating light situated in the outboard bearing symbol

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on the control desk top. A second contact is parallel with other circuit breaker tripping devices. A third contact closes a circuit to the station alarm. As continuous operation of the alarm would be undesirable, an alarm cutout button is provided on the control desk whereby the operator can stop the alarm. This does not prevent the alarm operating, however, should trouble occur at any other point, nor is it necessary for the operator to reset the alarm for this particular trouble spot for it will automatically reset when the trouble is cleared. It is impossible, however, for the operator to extinguish the indicating light; this happens only when the trouble is cleared and the device reset by hand. As a further precaution, these instruments are so arranged that they cannot be reset until the trouble is cleared. The location of the instrument in most cases is near the possible source of trouble, and as the unit cannot be started until this device is reset, it is hoped that the operator will be induced to make a closer inspection of the trouble than he would if the whole operation could be handled from the control room. All protective devices operate in a similar manner, some of which require auxiliary relays. In the main, however, all possible auxiliary equipment has been eliminated.

The station as a whole is protected by devices for the following: High pump pressure, low station suction pressure, high line discharge pressure, and incoming power overcurrent, each of which will trip the main incoming line breaker, sound an alarm, and operate an indicating light. Each motor is protected against high temperature of bearings, motor overcurrent and winding high temperature. With the exception of motor winding temperature, all these devices trip the individual unit, sound an alarm, and operate an indicating light. Each pump is protected against high temperature in bearing and casing. When any of these devices operate, the unit is taken off the line, an alarm is sounded, an indicating light is illuminated, and both suction and discharge valves close. Also, the station is provided with protection against low air pressure and high sump level.

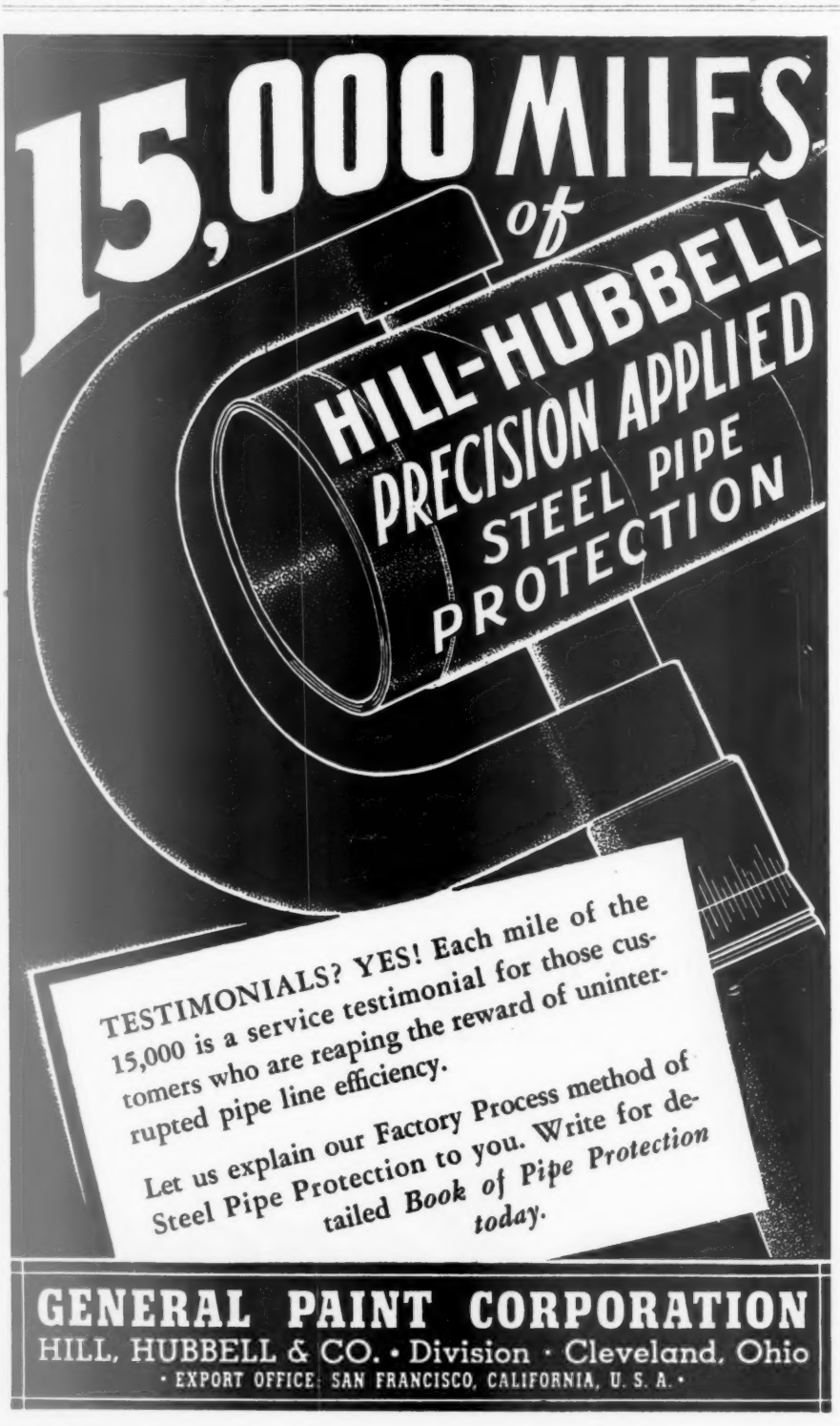
Normal stopping of a unit can be done from three points: The "stop" button on the control desk, the control switch on the switchgear, or a "run-stop" push button situated near the pump in the pump room. There is only one place, however, from which these units may be started and that is from the control desk. The "push" button in the pump room and the control switch on the switchgear must be in the "run" position before a unit can be started. This "run-stop" push button is arranged for padlocking in the "stop" position, thereby providing a safety feature for mechanics working on the pump.

The motor vent fans are so connected that they are started and stopped automatically with the main pump motors. This arrangement leaves no possibility of the motors operating without adequate ventilation. The control desk is provided with an indicating light to assure the operator that the motor vent fans are in operation. Also included on the control desk is an indicating lamp for the control room blower, which will assure the operator that he has a positive pressure in the control room at all times.

A few words may be said concerning the conduit installations. Virtually all conduits are below floor level and enter a pull box or "pit" under the sequence control cabinet. A cable trench, extending the full length of the switchgear, and connecting to the pull box under the sequence control cabinet, is provided to facilitate control wiring between these units. All electrical equipment in the pump room, including motor-operated valve units, lighting fixtures and fittings are of the explosion proof type. Conduit runs from a gaseous area through the firewalls or into the control room are sealed with sealing condulets and packing glands. All outside lighting fixtures and those in the motor room are of the vapor-tight type. All fixtures and fittings in the control room are of the conventional type.

Parts of this plan have been used on other pipe lines in one form or another, and some parts were developed for this particular project, but by using this plan of station control the contamination of different products in transit is held to a minimum, the costs of operation is reduced, and the continuous delivery of full capacity is more nearly assured.

★ ★ ★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By **PAUL V. SANDERS,** *Chemical Engineer*
D. W. Haering and Company, Inc.

EXCLUSIVE THE vast network of pipe lines, comprising the agency for the collection and distribution of petroleum and petroleum products, represents by far the most important factor in the modern transportation methods employed by this industry. Uninterrupted flow from field to refinery and from refinery to consumer is mandatory; shutdowns cannot be tolerated.

Operational problems inherent to this phase of the industry are numerous, but none assumes greater importance than the possession of sufficient and properly conditioned cooling water. In certain isolated localities the raw water supply for station use is both adequate and of a quality that holds corrosion and scale to a minimum. Generally speaking, however, the reverse is true, and the services of a chemical engineer specializing in water conditioning are a must if plant efficiency is to be maintained.

Engines and compressors generate heat that must be dissipated through cylinder walls and connecting rod surfaces to the cooling media. Aftercoolers and intercoolers must transmit heat through transfer surfaces. Any insulation, caused by the deposition of salts or corrosion products within a water jacket, defeats the purpose of the cooling system. A scale of 0.020 in. thickness may reduce the transfer of engine heat by 10 per cent; 0.125 in. by as much as 30 per cent, and 0.25 in. by 40 per cent.

A control system, instituted under the direction of a competent water treatment chemist, will eliminate corrosion and scale problems in these cooling systems. The establishment of any control system must be based on chemical analyses of the water, a study of the cooling system design and existing conditions in the equipment, as well as consideration of the metals, temperatures and circulating conditions that affect velocity and turbulence.

Problems occurring in these systems are influenced by atmospheric contamination from gases, such as oxygen, carbon dioxide and hydrogen sulphide, and bacteria, algae, and dust. This frequently introduces appreciable quantities of silica into the equipment. Velocity, temperature, and incomplete wetting of the metal surfaces are design features, and a variety of metals and alloys present in systems encourage and introduce water problems inherent to the systems, unless corrective treatments are employed.

Corrosion in engines and compressors is frequently severe as a result of mechanical factors as well as of corrosive chemical equilibria. Scale is a problem in cooling systems and although carbonate deposits are most common, both silica and sulphate deposits occur with regularity. Temperature conditions in much heat transfer equipment are such as to cause appreciable deposition. Silica is probably the number one offender because it acts as a binder for miscellaneous suspended matter and in most cases will occur regardless of the mechanical treatment employed. Silica deposits in exhaust valve jacket of internal-combustion engines are not unusual. Corrosion products are invariably present in scale depositions and objectionable accumulations of mud and sludge add to the necessity of removing materials that are insoluble under operating conditions.

Bacteria, gases, dust and algae no longer need be allowed to destroy maximum efficiency in compressor stations.

Very hard waters require both external and internal treatment. Zeolite or modified lime-soda softening may be employed as pre-treatment, but this must be followed with internal conditioning to maintain insoluble material in solution or true colloidal suspensions. Concentrations of the solids in the cooling system must be kept at reasonable figures, with a small percentage of the circulating water dumped periodically according to control tests on the water. The chloride method of concentration control is a satisfactory measurement for this. It is our experience that each system has a maximum concentration ratio based on system design, operation, and characteristics of the water used. The chloride control system works two ways —it avoids too high concentrations and it prevents unnecessary dumping of large quantities of water.

Beta glucoside and certain of its derivaties are used for the prevention of scale formation in such systems. The amounts required are quite small and all these chemicals possess the qualities of preventing heavy sludge formations and are positive preventives of silica deposition.

Chemically, oxygen and carbon dioide are the worst offenders so far as corrosion is concerned. Of almost equal importance, however, are the chloride and sulphide ion. High chloride contents have a destructive effect on protective films. The presence of the sulphide ion, either as hydrogen sulphide or sodium sulphide, greatly accelerates the corrosion rate. Differential aeration is a very vital factor affecting exhaust valve guides in engines and plays an important part in corrosion of idle equipment. Voltaic couples as the result of uneven scale deposition or of repairs by welding are common corrosion accelerators present in many systems. Velocities, which may run as high as hundreds of feet per second, and impact pressures, which may reach thousands of pounds per square inch in connecting rods at stroke reversals, introduce cavitation and erosion as serious corrosion factors.

As oxygen control is apparently impractical because of recurring contamination that would necessitate large amounts of chemicals for removal, and because other factors are equally important in their influence on corrosion rate, the use of film inhibitors for corrosion control is indicated.

A variety of materials have been employed for this purpose, among others calcium and sodium hydroxide, sodium carbonate, silicate, phosphate, tannin, dichromate, and the organic glucoside derivatives known as the glucosates. These all have as their object the depositing of a more or less impervious film on the metal surface that is in contact with the water. These films may be of appreciable thickness such as are formed by the silicates, or they may be of molecular dimension as formed by the organic glucosates. The hydroxides, under a restricted set of conditions, appear to have some effect on certain metals, but they would have a detrimental effect on any nitrogenous or sulfonate film formation. Caustic and silicate treatments are objectionable as they cause hard scale formations and by binding the dirt and iron oxide present in the cooling water may cause plugged supply lines and water passages. The phosphates are expensive and form heavy sludges,

(Continued on Page 212)

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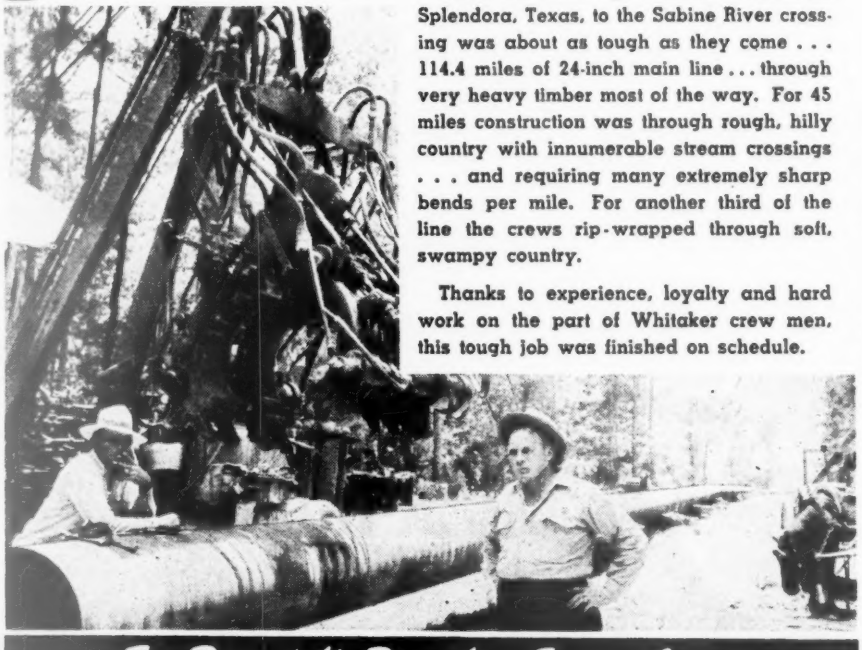
Thanks to experience, loyalty and hard work on the part of Whitaker crew men, this tough job was finished on schedule.



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(Continued from Page 208)

whereas the tannins are just as likely to accelerate corrosion as to inhibit it. The dichromates are erratic and inefficient at cooling system temperatures.

Natural glucosides that do not belong to the tannin grouping were first used for scale and corrosion control in aqueous systems in 1931. Economically available, their colloidal character, unwieldly structure, hydroxyl groupings, and scale-removal properties suggested their application as corrosion inhibitors of the film forming class. As inhibitors that do not remove existing corrosion products accelerate corrosion, the properties of the glucosides that remove calcium, magnesium, silicon; and iron are of prime importance.

The removal of carbon dioxide by the use of alkalies is of little, if any, value in this type of system as the resulting carbonates and bicarbonates release carbon dioxide at the heat transfer surfaces anyway. pH values should be maintained between 7 and 9 and alkalies may be used to increase pH values. In order to avoid sludge formations, sodium glucosate is used for this purpose.

Sodium chrom glucosate through film formation will control the action of the chloride and sulphide ion. Concentrations are important in their effect on the corrosion rate and concentration control is vitally important if corrosion is to be stopped. The sulphide ion, usually present in the raw water as hydrogen sulphide, may be removed by aeration. It is of no value to convert it to sodium sulphide and larger quantities of chrom glucosate are required if it cannot be removed as suggested.

Voltaic couples due to scale deposition may be eliminated by cleaning and maintaining the equipment clean. In some cases phospho glucosate is used to clean rapidly the system before adopting routine treatment. There is no excuse for repeated cleaning of this sort, however, as properly treated water in properly operated equipment will not form scale. Corrosion due to dissimilar metals is best controlled by the intelligent selection of metals before manufacture but where such conditions do exist, the chrom glucosates afford a large measure of protection.

Corrosion due to differential aeration and turbulence can be eliminated by correct design and ultimately better control may be expected. A film inhibitor such as chrom glucosate is of value and the removal of scale helps to reduce both factors. Erosion is largely due to suspended solids, entrained gases, and rates of flow. Suspended solids may be largely controlled by the glucosates utilizing their effect of holding materials in true solution or colloidal suspension. The effect of gases is efficiently reduced by the chrom glucosates.

Scale and corrosion problems in a jacket cooling water system can be controlled. An operator of a compressor station no longer need tolerate scaled or corroded jackets and liners. Better performance, longer equipment life, and decreased maintenance costs in water using equipment are available. ★ ★ ★

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Model 12 digging trench in coral rock for cable on Eniwetok, Marshall Islands. *Official U. S. Navy photo.*

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Model 12 trenching for gathering line of Plantation Pipe Line Co. *Acme News photo.*

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P 615.222

PRESSURE WELDING OVERLAND PIPE LINES

By **E. P. JONES,** *General Superintendent,* Pressure Weld Company

EXCLUSIVE WITHIN the past four years some 1280 miles of overland pipe, ranging from 2-in. through 24-in. diameter has been welded by the oxy-acetylene pressure welding process.* This new semi-automatic process has proved its adaptability to all types of right-of-way conditions while producing weld joints of excellent quality in record time. These factors combine to form an overland pipe welding procedure unusual in pipe line construction. This article will cover the major features of the pressure welding process and outline some of the recent developments in process and equipment.

*Process Patents held by The Linde Air Products Company. Apparatus Patents pending by Pressure Weld Company.

Three major features of the pressure welding process are the following:

1. **A field weld of excellent quality.**
2. **A semi-automatic process wherein operator skill plays a minor role.**
3. **A system of pipe line construction wherein substantial savings in man hours, materials, and equipment is effected.**

▸ **The process.** The pressure weld is formed at subfusion temperatures of the materials being joined, as the result of transinterface crystallization and diffusion. The mechanism for obtaining these conditions is relatively simple and accurate. The materials to be joined are placed in abutment under a holding end force. The temperature in the weld zone is raised, by means of oxy-acetylene flames, to temperatures above the critical temperature of the steel (2100-2500°F.). When the proper temperature is obtained, as noted by the plastic condition of the metal in the weld zone, the final welding end pressure, equal to 3000-4000 lb. per sq. in. of joint cross-section, is applied. This causes upsetting of the pipe material producing a smooth rounded upset on the internal and external surface of the joint.

▸ **The pressure weld.** The weld joint produced by the pressure weld process

FIG. 1. Welding clamp suspended from side-boom installed on tractor.

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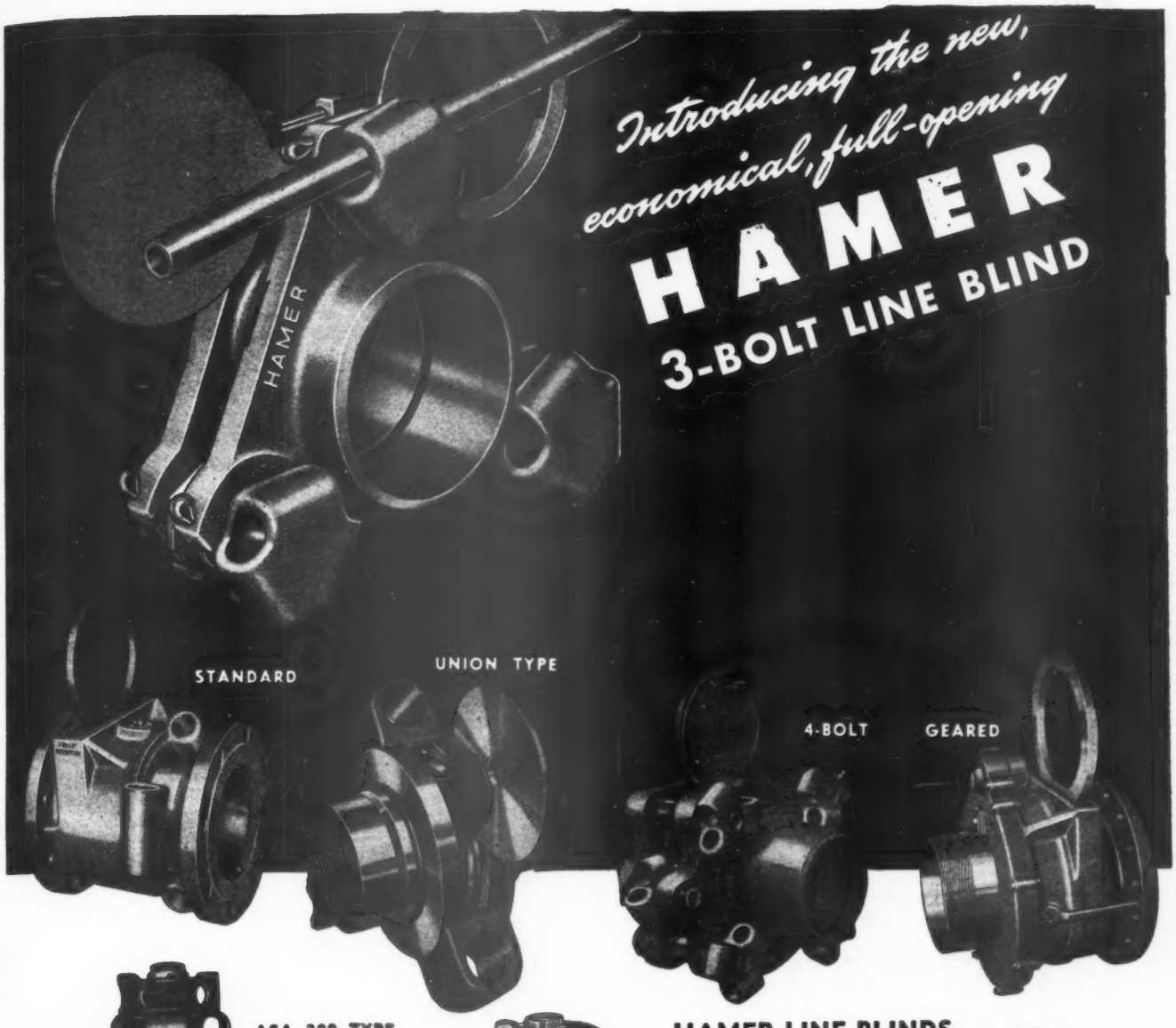

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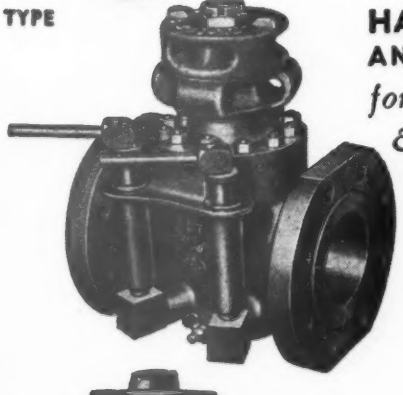

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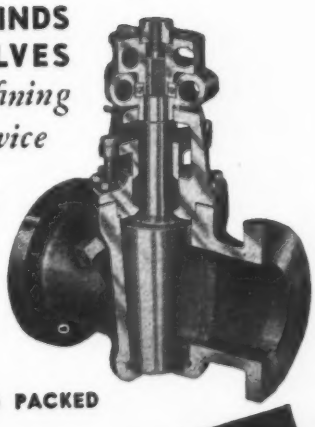

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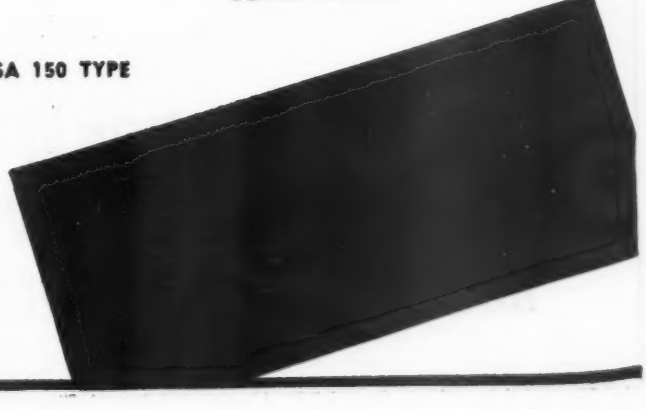

is unique in several respects. By virtue of having been made at subfusion temperatures, cast structure is avoided. There are no oxide inclusions, porosity, laps, cold shuts, fish eyes, pipes, etc. A good proof of this is the fact that X-ray examinations show the pressure weld to be clean and homogeneous, in all cases.

No change in chemical composition of the pipe takes place. Microscope examinations of weld cross-sections show that the structure of the material in the weld zone has only been affected to the extent of producing a slight grain enlargement over that of the parent metal.

Physical tests on the welds show them to be as strong or stronger than the pipe material. They possess ductility and have high impact and fatigue resistance. During the welding on the recently completed 24-in. O. D. by ¼-in. wall thickness pipe line for the Tennessee Gas and Transmission Company, over 4700 physical tests were made on welds removed from the line. These results showed average ultimate tensile strength of over 75,000 lb. per sq. in. with approximately 25 per cent elongation across 2-in. centers transverse to the weld zone.

There are no excessive penetrations of weld metal or "icicles" on the inside of the welds to damage the pipe cleaning equipment or "go-devils." A smooth rounded upset that will average approximately 5/32 in. in height (depending upon the wall thickness) remains on the inside of the pipe. This upset does not restrict the flow in either oil or gas pipe lines as proved by the entirely pressure-welded pipe lines now in operation, delivering in each instance in excess of designed capacities.

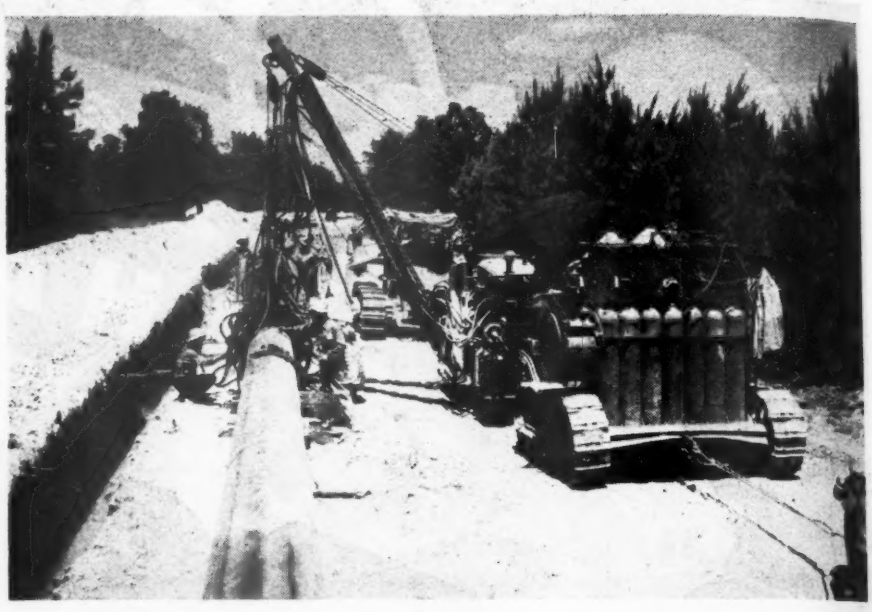

FIG. 2. Pressure welding equipment in operation.

▶ **The pressure welding equipment.** The acid test for any welding equipment is its ability to stand up under right-of-way conditions. The laying of pipe line across desert country, swamps, rice fields, hills, and other types of terrain has shown that this semi-automatic welding process is portable and practical. Fig. 2 shows the pressure welding equipment operating under ideal right-of-way conditions.

The welding equipment is self-contained. The welding clamp is suspended from the side-boom installed on a standard tractor, as shown in Fig. 1.

The hydraulic equipment is built on the side of the tractor and the hydraulic pump is operated by the tractor tail-shaft auxiliary drive. Water cooling is supplied to the welding clamp through a closed cooling system with circulation provided by a separate pump also driven from the tractor take-off.

Special trailers have been developed to carry the acetylene generators and oxygen cylinders. These are constructed so that in mud and swampy places the trailer floats when the pneumatic wheels become inoperative. In some cases, trailers with caterpillar tracks have proved advantageous. (See Fig. 2.)

It has been found that the acetylene generators and other oxy-acetylene equipment function reliably under the most severe right-of-way conditions.

The welding clamp has undergone considerable development since its introduction. The present design incorporates many features to eliminate the human element from the welding process. To this end, a procedure has been established for qualifying the machine and operator so that settings for the oxygen and acetylene regulators along with the

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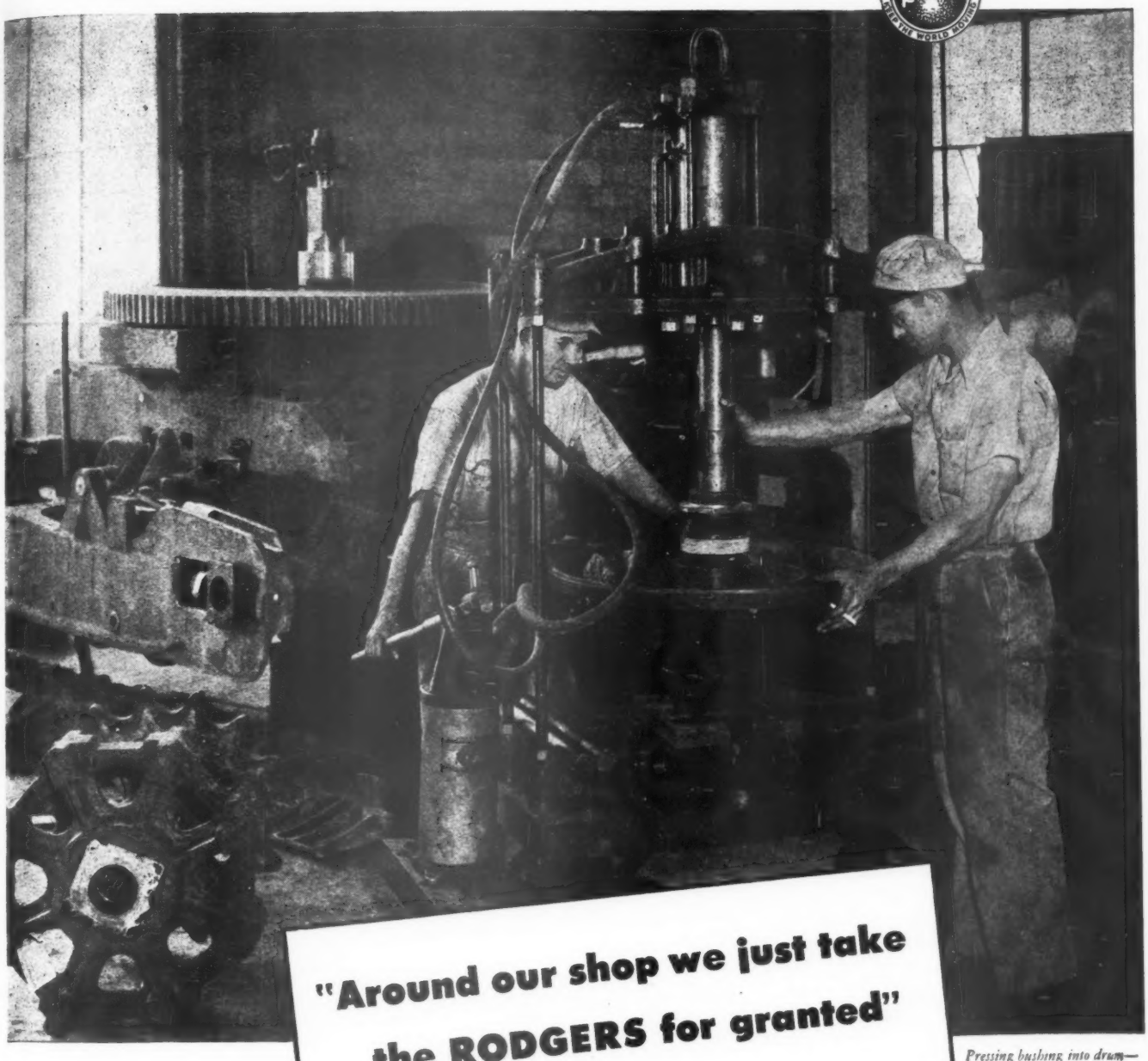

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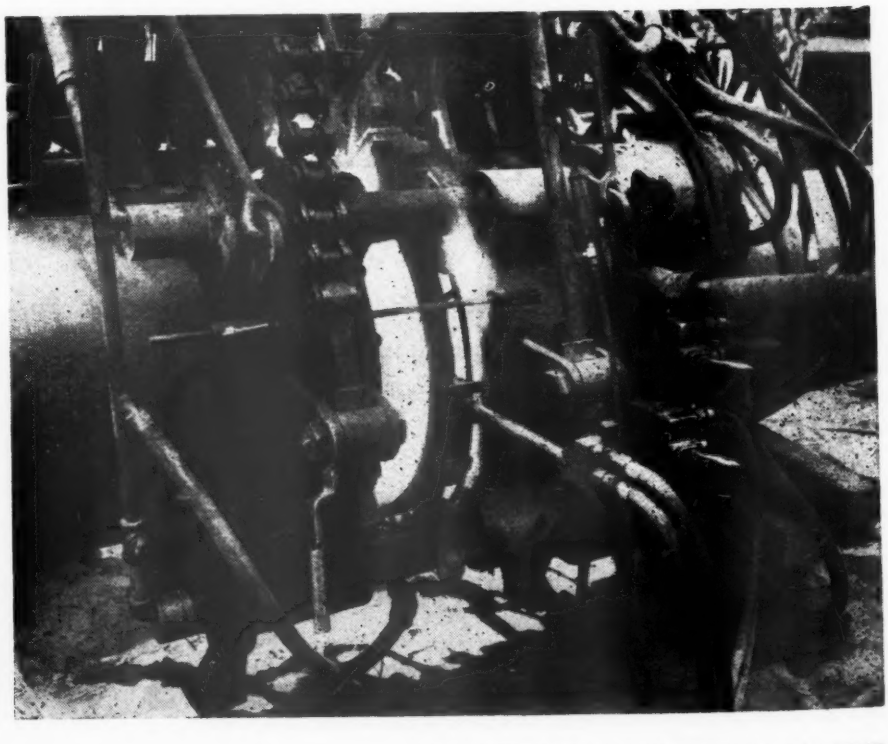
pressure readings of the hydraulic gages can be recorded, and adhered to. Each morning, qualifying welds are made and tested on the spot so that an accurate check on the quality of the weld is obtained without having to wait on the result of laboratory tests. Frequent checks are made during the welding of the line, and when any appreciable change in conditions has been noted.

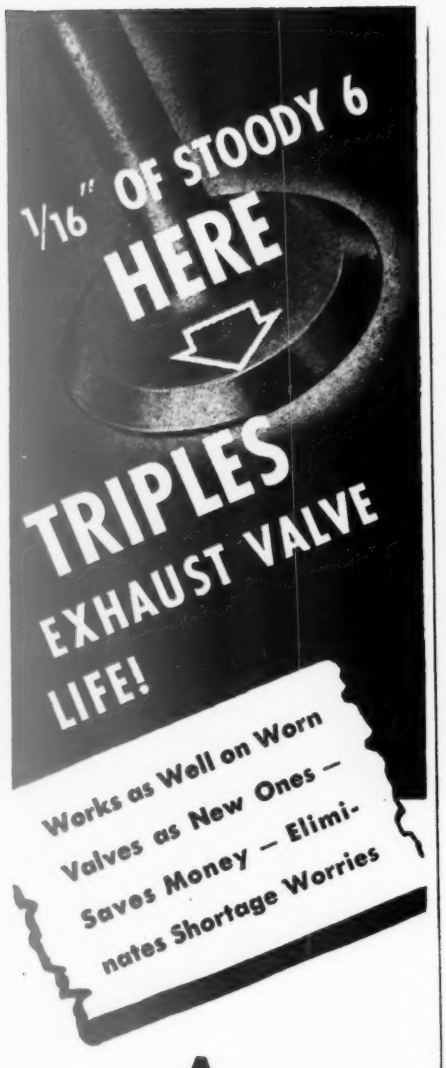
Hydraulic means are used to grip, align, and produce end force for pressure welding. The welding clamp, suspended from the tractor boom opens like the clamshell bucket used by excavating machinery (Fig. 3). It is lowered by a winch over the ends of the pipe to be welded. On contact with the pipe, end saddles take the weight of the machine so that the open halves close about the pipe and are latched together by hand operated toggle-acting latches.

Hydraulic cylinders, placed vertically on the top of the clamp, operate through rods and roller chains to apply force to the inclined surfaces of the gripping dogs. These move in radially against the pipe surface, rounding up any slight

FIG. 3. Welding clamp opens like clamshell bucket.

FIG. 4. After ignition flames are placed directly in the groove.

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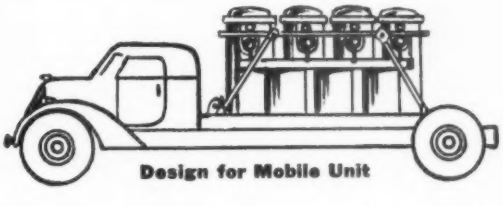

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oval tendency, and aligning the edges to be joined. Hydraulic end cylinders force the pipe together under controlled hydraulic pressure.

▸ **The welding procedure.** When the pipe is clamped and aligned under a holding pressure equal to approximately 1000 lb. per sq. in. of joint cross-section, the welding cycle is started. The gases flowing to the welding heads are turned on by means of quick acting valves. After igniting, the flames are placed directly in the groove (Fig. 4) formed by the beveled ends of the pipe (10 to 20 deg. included angle). This provides heating while the slight feather of acetylene on the flames insures a non-oxidizing atmosphere, thus eliminating any chance for oxidation to occur. When the welding temperature is reached, the final or welding pressure is applied to produce the weld upset. An electric signalling device is used to warn the tractor driver when sufficient upset has been secured and he immediately reverses the flow of oil to the hydraulic cylinders, retracting the welding clamp.

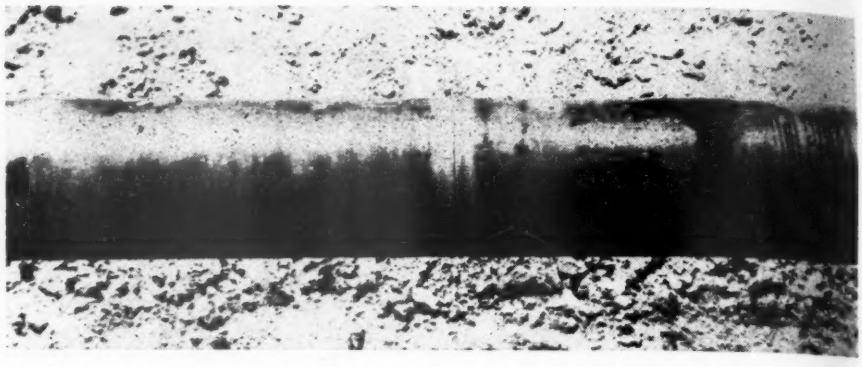

FIG. 5. Typical pressure weld in 16-in. O.D. by ¼-in. wall pipe.

The welding flames are reciprocated slightly across the weld upset at the end of the weld cycle to produce a lightly fused, uniform-appearing external upset. This eliminates any traces of the original edges of the pipe ends. A typical pressure weld is shown in Fig. 5. This is a weld in 16-in. O. D. by ¼-in. wall pipe.

The end point of the welding operation is not based upon time, but upon the obtaining of a predetermined amount of upset or gather. Thus, any slight differences in wall thickness or composition are compensated for: First, by bringing the metal in the weld joint up to welding temperature and correct plasticity without regard to time, and, second, by obtaining a uniform amount of upsetting of the plastic metal in the joint.

The welding times for various pipe wall thickness are shown in the following table:

TABLE 1.

Wall thickness of pipe	*Approximate heating time required*
.187 inch	45 seconds
.203 inch	50 seconds
.238 inch	55 seconds
.250 inch	60 seconds
.375 inch	90 seconds

All grades and compositions of line pipe are readily pressure welded with time approximately as listed above. Daily weld production will obviously depend upon right-of-way conditions, but experience has shown that average production on the "big inch" sizes will approximate 135 welds per day (approximately 1 mile). On the smaller sizes, more rapid progress will be made so that up to 200 welds per day can be expected.

▸ **Summary.** The past few years have seen the introduction of the pressure welding process to overland pipe lines. It has proved to be a revolutionary departure from accepted methods.

High quality field welds are produced under all conditions of weather and terrain. The so-called "Monday morning" welding has been eliminated.

Pressure welding has provided mass production methods to the pipe line industry while reducing welding crews and auxiliary equipment. Neither welding rods nor electrodes are used.

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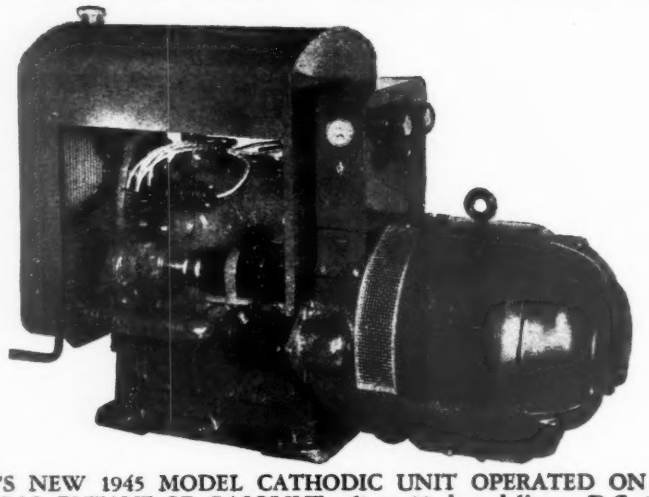

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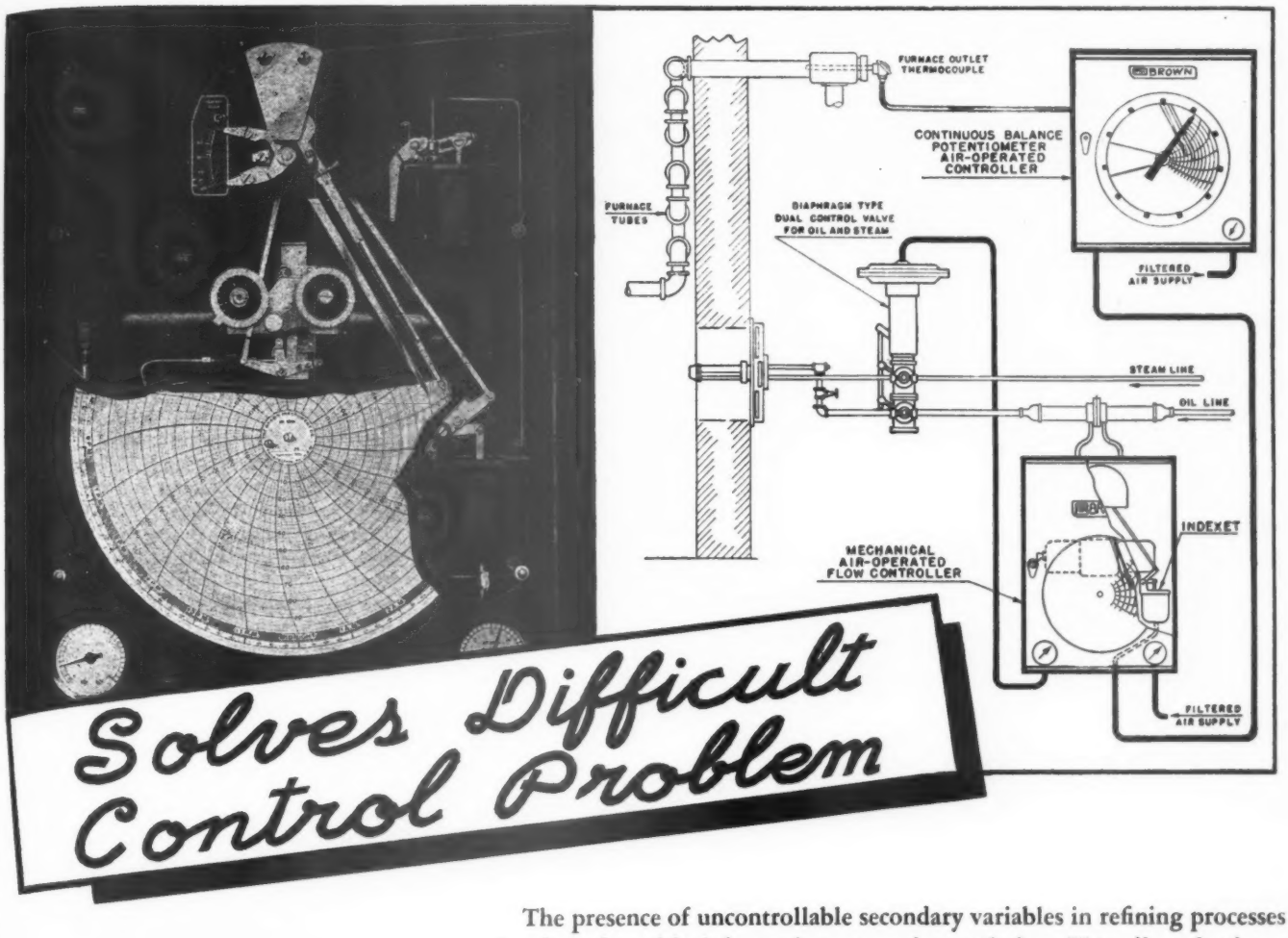
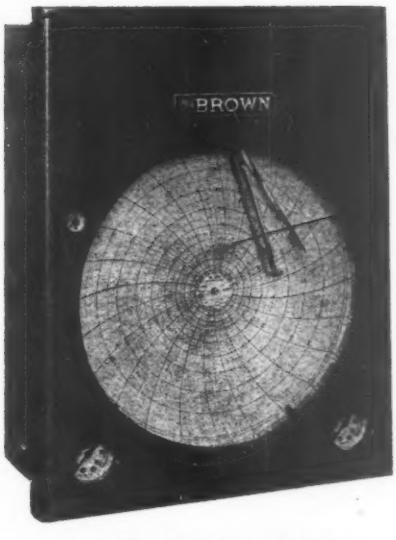


Solves Difficult Control Problem



BROWN RATE OF FLOW CONTROLLER RECORDING NEW-MATIC RECEIVER

The presence of uncontrollable secondary variables in refining processes is often the critical factor in automatic regulation. Hot oil outlet is an excellent example of how control of the main variable can be upset.

In such cases, the functioning of a single automatic regulating instrument must be backed up. The Brown Indexet is a simple, reliable and well-known method for accomplishing this result.

The Brown Indexet construction-wise, is a pneumatic connection between the pointer of a primary instrument and the control index of a secondary. Each position of the primary pointer reflects itself in a new setting of the control index of the secondary.

In order to be on top of the job, control sensitivity or throttling range must be set at a maximum point of sensitivity. When so doing, a controller is at the mercy of these maverick variations. Limit stops on the secondary instrument permit maximum sensitivity adjustment and yet prevent abnormal over-travel.

The Brown Indexet is typical of the advanced control technology so evident in Brown products.

For full details send for Bulletin 89-1. THE BROWN INSTRUMENT COMPANY, a division of Minneapolis-Honeywell Regulator Company, 4475 Wayne Avenue, Philadelphia 44, Pa. Offices in all principal cities. 119 Peter Street, Toronto, Canada—Wadsworth Road, Perivale, Middlesex, England—Nybrokajen 7, Sweden.

BROWN *NEW-MATIC* TRANSMISSION SYSTEM

CONSTRUCTING PIPE LINE RIVER CROSSINGS

By **ROBERT L. BUCK,** Williams Brothers Corporation

EXCLUSIVE THE most recent pipe line river crossings constructed by the company with which the writer is connected were included in the Tennessee Gas and Transmission Company's 24-in. natural gas line that was completed at the end of 1944. Prominent crossings in this system are the Kentucky River, Cumberland River, Tennessee River, and Mississippi River, all of which were constructed by the Williams Brothers Corporation of Tulsa, Oklahoma.

Possibly the most representative crossing in the system was that of the Cumberland River near Ashland City, Tennessee, as in it all major river crossings construction practices were combined.

Much attention was drawn to the Cumberland in that it was near the center of the Tennessee Gas and Transmission Company line and the ground-breaking ceremonies for this new system were held on the banks of the Cumberland River.

The Cumberland crossing consisted of three 16-in. lines with a header on each side of the river that tied into the 24-in. main line. As the Cumberland is a navigable river, the level of which is governed by a series of locks, it was necessary to construct the crossing in complete accordance with the specifications of the U. S. Engineers as well as the Tennessee Gas and Transmission Company.

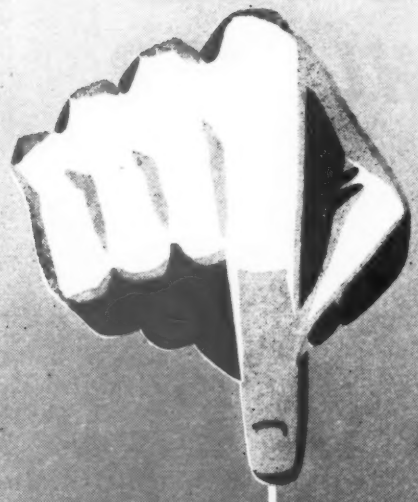
The entire channel crossing of the Cumberland was solid rock.

Construction began with bulldozers and draglines preparing the right-of-way between the river edges and the header sites. As work on the right-of-way progressed large barges were brought to the site. These barges were 130 ft. long and 20 ft. wide, and 3 drilling rigs of the water well type were mounted on each of two of the barges.

In mounting, the drill rigs were spaced to coincide with the ditch lines of the

Tennessee Gas and Transmission Company's 24-in. pipe line built in 1944. This shows the crossing at Clear Lake, Louisiana, in construction.

Same pipe line at Cumberland River crossing. Holes are being drilled for dynamite charges.



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250 TRENCHLINER

● Large rocks or heavy roots, shock loads of any kind can't damage the Parsons 250 Trenchliner. Safety overload clutch slips and stops machinery when buckets hit impassable obstructions in the trench. Band type safety clutch is spring loaded, quickly adjusted to provide proper tension for any type of digging. Mounted directly on the excavator drive sprocket, it is automatic in operation, always on guard against breakage that might cause delay and expense. Maximum production continues without interruption because the overload clutch provides safety and flexibility.

Band type safety clutch is spring loaded, easily accessible, quickly adjusted.

THE PARSONS COMPANY

KOEHRING SUBSIDIARY **NEWTON, IOWA**

TRENCHING EQUIPMENT

river, and by using one barge on each side of the river two holes could be drilled in each ditch line at the same time. Ditches near the edge, where it was not necessary to blast, were dredged to the required depth by diesel powered sand pumps. These pumps were mounted on steel barges that were constructed in the company shops at Houston, Texas, and Chamblee, Georgia. Ditching for header installation and between the headers and the river edge was done with backhoes and draglines.

Pipe for the crossing was then brought in and welded in sections. Each weld was reinforced by a sleeve, having first been tested with air pressure. The sections were then coated and wrapped and river clamps were placed at the required intervals. Wooden mats were placed around each section covering the coating and protecting it against being scarred.

At the completion of the drilling in the river channel, a total of 450 holes, a representative of the powder company was brought in to supervise the loading of the holes and to make the shots. The Cumberland crossing required three shots. The first and largest shot discharged 48,000 lb. of dynamite at one time. The other two were 32,000 lb. and 24,000 lb.

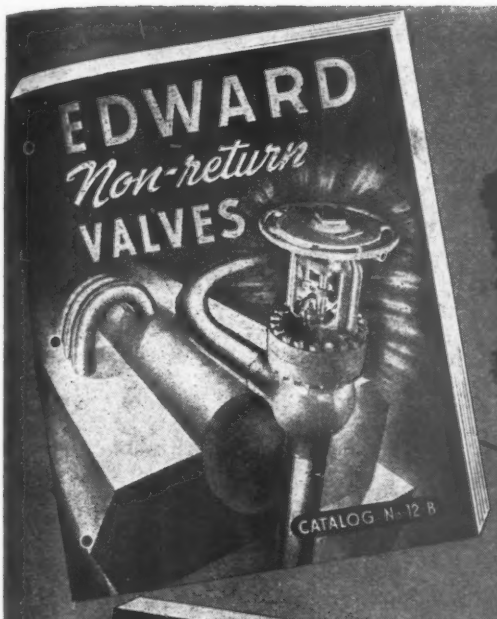
After the shots were made the process of cleaning out what debris was left in the ditches began. This was started with dredges, draglines and clamshells working from barges, but this procedure soon proved to be too slow. To speed the progress a dipper dredge, with a 26-ft. stick and a 1½-yard bucket, was brought in. This dredge did the job perfectly, but for one fact. The stick was 2 ft. too short to reach the required depth. Obtaining this additional 2 ft. with draglines and clamshells would have meant a marked delay, but through the cooperation of the U. S. Engineers office the level of the river was lowered 2 ft. at the vicinity of the crossing. By doing this it was easy to obtain the necessary depth with the dipper dredge. The excess fill from the ditches in the channel was loaded on barges and moved to a point away from the working area. After the lines were installed this fill was returned, by barge, and used in refilling the ditches.

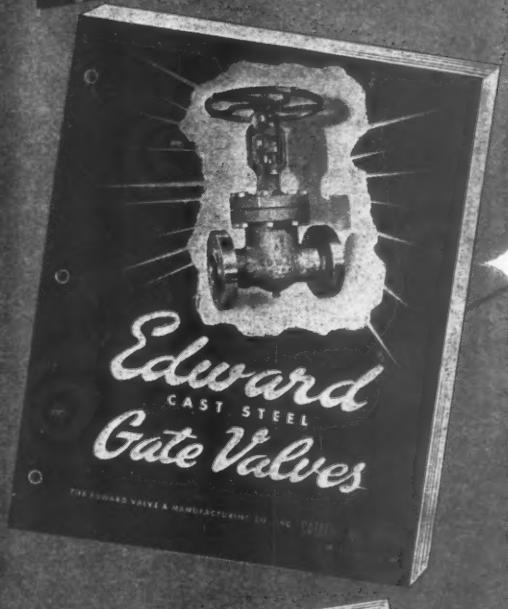
After the ditches had been cleaned out and inspected, each line was pulled across the river and into position. The power for pulling was provided by two D-8 tractors equipped with heavy duty towing winches.

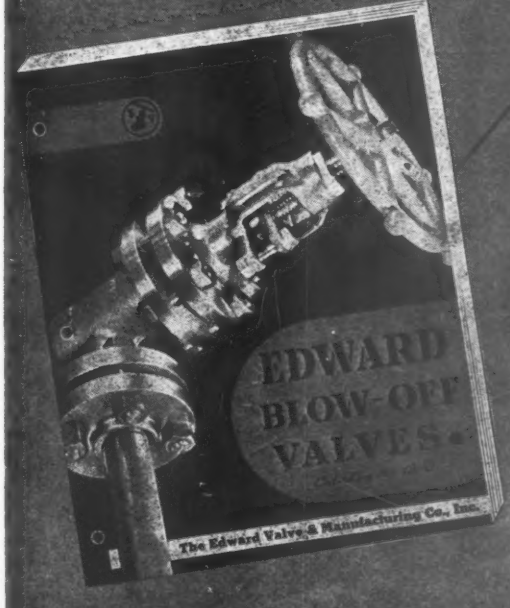
The dipper dredge was again used in back-filling the ditches in the river. Bulldozers and draglines were used in backfilling the banks of the crossing. ★★★

Oil board for Georgia

With the imminent possibility of Georgia's becoming an oil producing state, a bill has been passed by the lower house creating a three-man oil and gas commission to regulate drilling and exploratory work.







THREE *New* "MUSTS" FOR YOUR VALVE DATA FILE

Non-Return Valves **Catalog 12-B**

Cast and forged steel in 300 to 2500 lb sp classes. Full dimensions, cross-section illustrations and descriptions. Maintenance hints, pressure drop data, pressure-temperature tables and other useful information. Every power station operator should have this helpful new catalog.

Gate Valves **Catalog 12-E**

Cast steel for service from 150 to 3600 lb. Description, with illustrations, of the new, basically different Edward gate valve line, including Intex integral seat construction, exclusive Edward guiding method, and other new features. An important catalog for steel gate valve users.

Blow-Off Valves **Catalog 12-D**

Design details and dimensions for Edward cast and forged steel blow-off valves. Installation and operating suggestions. Moderate initial price, extremely low maintenance costs and operating dependability make Edward blow-off valves standard equipment for thousands of boiler plants.

The Edward Valve & Mfg. Co., Inc., 1592-145
East Chicago, Indiana

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EDWARD *Steel* VALVES

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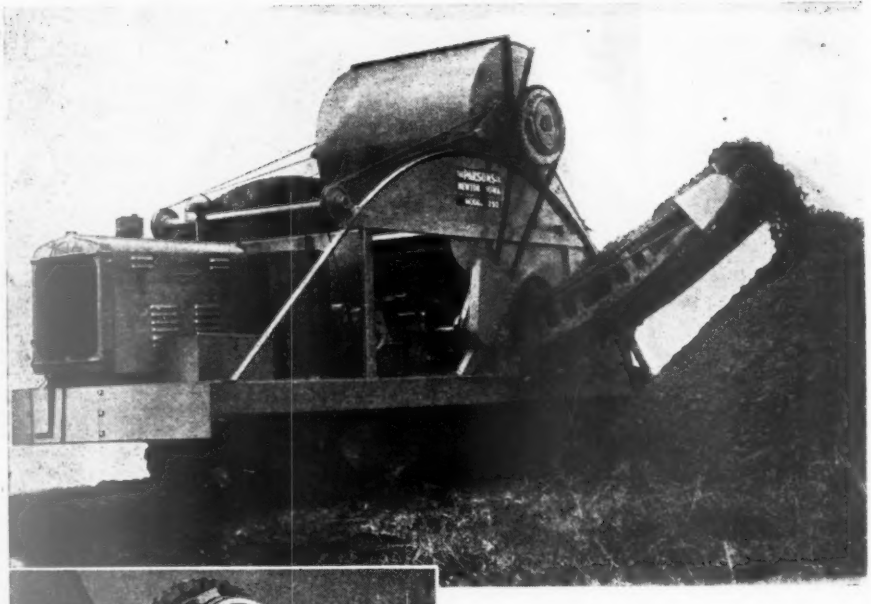
PARSONS

250 TRENCHLINER



Band type safety clutch is spring loaded, easily accessible, quickly adjusted.

● Large rocks or heavy roots, shock loads of any kind can't damage the Parsons 250 Trenchliner. Safety overload clutch slips and stops machinery when buckets hit impassable obstructions in the trench. Band type safety clutch is spring loaded, quickly adjusted to provide proper tension for any type of digging. Mounted directly on the excavator drive sprocket, it is automatic in operation, always on guard against breakage that might cause delay and expense. Maximum production continues without interruption because the overload clutch provides safety and flexibility.

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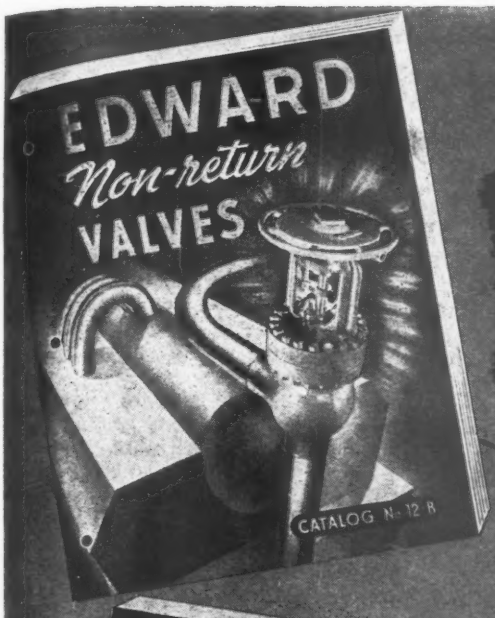

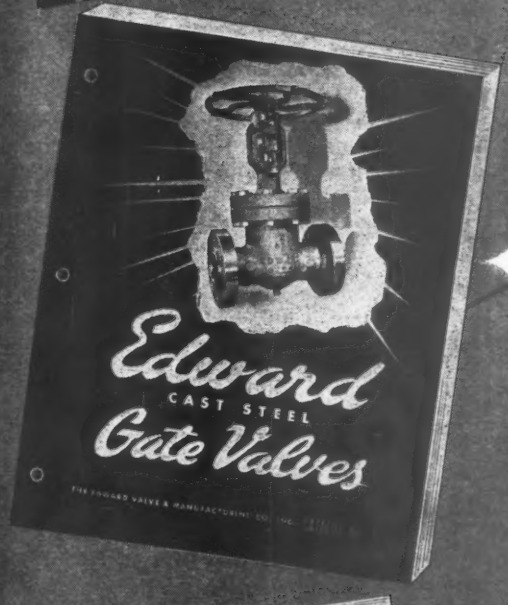

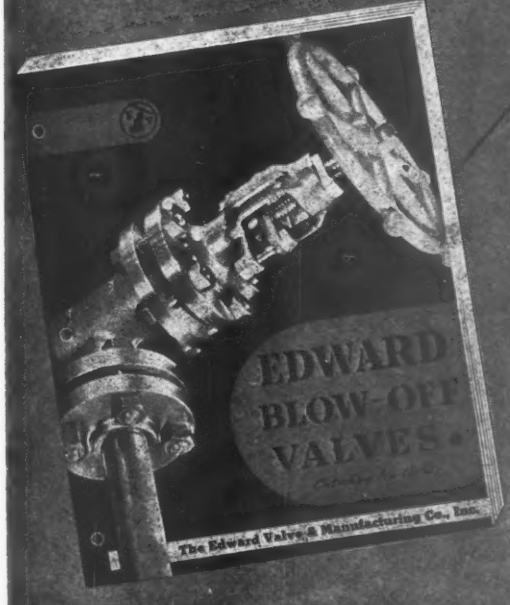

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EDWARD *Steel* VALVES

P 615.63

NEW METHOD OF TAKING UP AND RECLAIMING PIPE LINES

By **J. P. NEILL**, *General Superintendent*
H. C. Price Company

EXCLUSIVE At no period in the history of the pipe line industry has the work of reclaiming pipe lines for more essential uses reached such important stages as at present. The war and its resultant critical material shortage has of course been the principal factor toward bringing this about. However, there are numerous other factors also contributing to this in that they are directly affecting the relative economics of reclaiming pipe lines.

The purpose of this article is to describe briefly one factor that has, by enabling reductions in the construction costs of pipe reclaiming, become of considerable importance in this field. This is a device known and patented as the Pipe Line Reclaimer (Patent No. 2,105,-602) that basically embodies the unique method of raising pipe to the surface by first cutting the earth loose from the buried pipe, then forcing the pipe to the ground surface by means of a vertically inclined attachment running under the pipe and serving as an elevator.

This attachment is in a V-shape with its length governed by the size and cover of the pipe to be removed. The lower section, being flat, slides along the bottom of the ditch while the upper inclined section, being a semi-cylindrical trough-shaped form guides the pipe and forces it upwards. A circular scraper is then attached to the elevator and serves to clean the pipe of all loose dirt or mud as it reaches the ground surface, thereby saving considerable work for the pipe haulers and cleaning machine. This operation is then followed by a pipe cradle and boom cat moving the pipe off to one side of the open ditch and placing it on accessible ground for the cutting or beveling crew.

The prime motive power for this operation varies according to the size of the pipe line, soil conditions, backfill depth, and nature of the terrain involved. As an illustration, in one case actual field experience shows the removal of a 6-in. line in sandy loam with an average cover of 18 in. and with fairly level terrain required a maximum tractor draw bar pull of approximately 32,000 lb. and a minimum of approximately 12,000 lb. Under these conditions the frequent occasions requiring the maximum draw bar pull necessitated the use of two medium sized tractors. In another case involving the removal of an 8-in. line in soil running from sandy loam to clay and rocks with an average cover of 24 in. and over very rough country required a maximum draw bar pull of approximately 50,000 lb. with a minimum draw bar pull frequently reaching as low as 12,000 lb. The latter work required two large sized tractors.

The advantage of reclaiming pipe by this method is gained chiefly by the speed by which it is possible to raise the pipe to the surface. Under ideal conditions and by proper preparation of the right-of-way in advance of the reclaimer so as to eliminate delays at highway, railroad or pipe line crossings, as well as in the sections of line buried in deep banks, etc., it is actually possible to raise from 8 to 9 miles of pipe a day. In turn, the fast progress made possible by the use of the reclaimer governs the other phases of pipe removal work and the entire operation is thus geared up accordingly.

Device cuts earth loose from buried pipe, forces it to surface by means of vertically inclined attachment.

Use of the machine has been proved practical on pipe sizes ranging from 2 in. to 12 in. Results have been equally successful on both screw pipe and welded pipe. In the case of screw pipe an elongated semi-cylindrical stripping shoe is used, the shoe having a beveled edge that enables the reclaimer to ride over screw collars or protruding welds such as those produced by the old ripple welding method. Because this method thoroughly loosens the ground first a very slight pressure is uniformly exerted by the elevator attachment in raising the pipe to the surface. This protects the pipe from damage or bending and overcomes a frequent source of trouble caused by raising long sections of pipe from the ditch bottom with boom tractors.

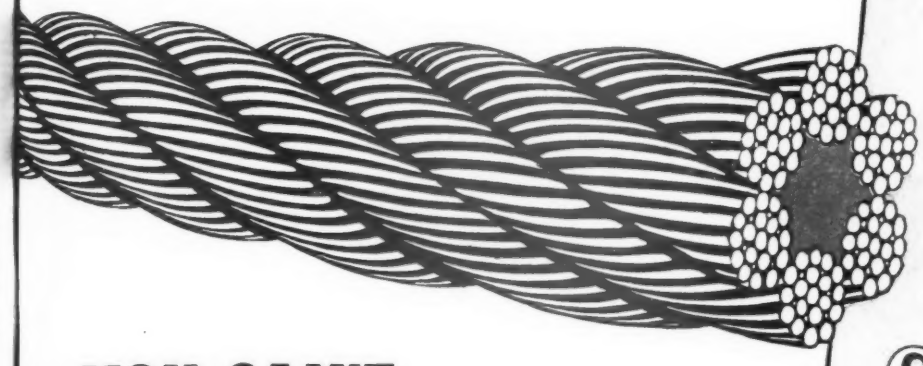
The length of line to be reclaimed, seasonal weather conditions, hauling distances, and available yard facilities must necessarily govern other phases of the work such as beveling, cutting collars, straightening, cleaning, and loading. When a pipe line of an appreciable length is involved, it is generally more advantageous to simply rough cut pipe into hauling lengths while on the right-of-way. In this manner the cutting and hauling of pipe, backfilling, and right-of-way clean up can be easily geared to the rapid rate of progress made by the reclaimer. If provisions are made for sufficient racks for storing large quantities of pipe hauled from the line, a systematically operated pipe yard can then be set up and run on a regular production schedule. Such pipe yard operations are not seriously hampered by weather conditions, workers are more easily supervised, transportation costs are lowered, and many other advantages are gained by the elimination of as much work as possible on the right-of-way.

Although the pipe reclaimer and its

(Continued on Page 230)

Pipe on ground after reclaimer has been in action. The reclaimer is towed by a tractor. This is on a 6-in. pipe line job in Kansas.

BLINC



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QUESTIONS AND ANSWERS

Q Why are three or more seizings recommended to hold the end of a rope when one would keep it from unraveling?

A *With non-preformed rope it is almost impossible to hold the strands sufficiently tight with one seizing. If rope lay is lost or if any of the strands is allowed to shift from its balanced relation with respect to the others, improper rope life will very likely result.*

Q Is it necessary to use seizings on a preformed rope?

A *It is not necessary to use seizings to keep preformed rope from unlaying because all wires and strands are set to their helical forms. However, it is advisable to use seizings to prevent the strands from being forcibly unlaid and distorted when cutting or handling the rope. Naturally, preformed rope must be seized when preparing it for socketing.*

Q Is it wrong to stagger the clips on a thimble and clip attachment?

A *Yes. The live end of the rope should be protected against crushing and abuse by placing the body of all clips against this side. All U-bolts should be on the short, or dead end of the rope.*

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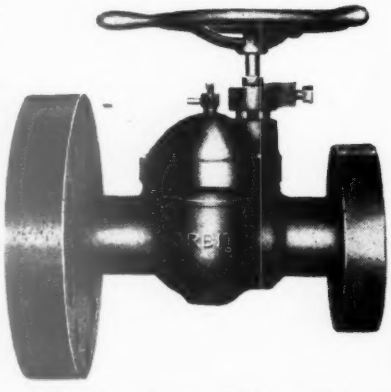
MASTER VALVE
WITH
UNEQUAL FLANGES

The ORBIT GEAR OPERATED MASTER VALVE makes your Christmas Tree more compact by eliminating the use of an adapter flange—also eliminating chances for additional gasket leaks. The Unequal Flanges are cast integral with the body of the Valve.



Orbit Gear Operated Master Valve

This valve can be furnished thru all fabricators of Xmas Trees or thru any of your local supply stores at a price comparable to that of other leading valves, YET, this valve requires no lubrication to effect a seal.

See 1944 Composite Catalog

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ORBIT VALVE COMPANY
TULSA, OKLAHOMA

The reclaimer is being used here on an 8-in. line in Oklahoma. Pipe is forced to surface by a vertically inclined attachment that is pulled along beneath the pipe, serving as an elevator.

Tractor is towing reclaimer on 6-in. pipe line job in Kansas.

(Continued from Page 226)

operations have been described briefly it may readily be seen from the foregoing that a greatly accelerated rate of progress is achieved through the use of this equipment and technique. Such progress results in substantially lowered costs to both the owner and contractor. Cost reductions of such an extent that in some cases pipe line operating companies may find it economically expedient to replace lines not used to full capacity with smaller size pipe, then utilizing the larger pipe at other locations.

Credit is due K. C. Knapp, inventor and patentee, who spent a great deal of time and effort in the building and perfecting of the reclaimer. Additional attachments are now being made, their operations studied and it is anticipated that in the near future improvements may be made that will afford the same operating technique in the reconditioning of pipe lines while in service. Exclusive territorial rights for the use of the reclaimer have been granted to the H. C. Price Co. of Bartlesville, Oklahoma.

★★★

Record producer

In 1932, because of royalty obligations, Phillips Petroleum Company was forced to drill a well against its wishes. That well, the No. 1 Gallman, has produced 2,400,000 bbl. of crude worth $2,490,000 and after 13 years still makes 500 bbl. daily. It is in line to set a new United States production record, *Philnews*, company magazine, has disclosed.

P 615.222

DETERMINING SOUNDNESS OF WELDS IN LINE CONSTRUCTION

By **WILLIAM E. CRENSHAW** and **D. E. ABBEY**
American Inspection Service

EXCLUSIVE IT IS now possible for the pipe line industry to know the soundness of its welding fabrication before pipe is lowered into the ditch. Uncertainty of the condition of pumping station equipment, in service for lengthy periods, which has resulted in the arbitrary discarding of thousands of parts, can now become a thing of the past. A non-destructive precision method of preventive inspection, presently available, makes this possible.

Non-destructive precision method of preventive inspection used at stations as well as in laying of lines.

This method, commercially developed under the trade name Magnaflux but heretofore limited to those plants and areas where a high line voltage was available, may now be obtained for the inspection of fabrication work in the field, as well as at pumping stations having only d-c. power, for the inspection of valve bodies, pressure lines, and engine parts.

By means of a high-amperage low-voltage current, obtained from specially constructed equipment mounted on a truck chassis, a magnetic field is placed in the part or in an area of the part, to be inspected. Wherever a discontinuity crosses the magnetic field at right angles, or nearly thereto (Fig. 1A, 1B) a reluctance is offered to its passage, with the result that some of the field, taking the path of least reluctance, pushes into the external air. Local north and south poles are set up along the edges of the discontinuity and, when a specially prepared powder of finely divided paramagnetic particles is sprinkled or blown over the area of inspection, those particles coming into contact with the external field are attracted to the poles and build up, outlining the extent of the discontinuity. (See Fig. 2.)

Inasmuch as discontinuities may occur longitudinally or axially with a part, it is necessary to control the direction of the magnetic field in a way to assure as nearly as possible its intersection with the discontinuity at right angles.

For longitudinal discontinuities a circular field within the part is employed (Fig. 3), whereas for transverse discontinuities, a longitudinal field within the part is used. (See Fig. 4.) The amount of magnetizing current is also carefully controlled. Too much current may bring out the flow lines and grain structure of the metal; or, indications may be obtained from such discontinuities as oil holes and castellations that are entirely non-relevant. Defects invisible to the naked eye thus become easily located and detected.

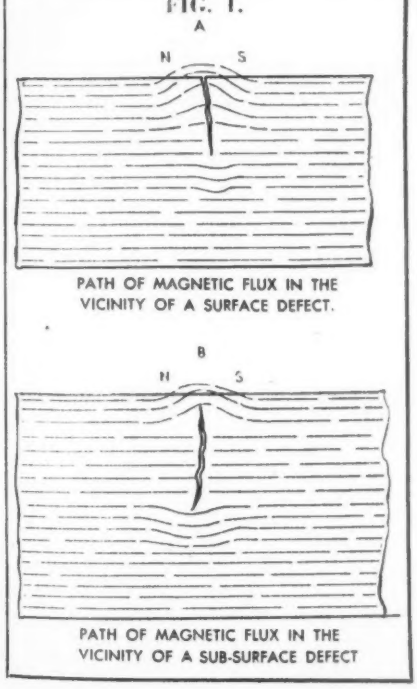
The method has particular application in the inspection of fabrication work in the field, as a means of assuring the soundness of all weldments before lowering in. Common defects in weldments are readily determined, and when found during fabrication may be reworked and again tested for soundness before passing to the next joint. It has sometimes been necessary to chip out and reweld as many as four or five times before soundness was achieved.

Undercutting and overlap are, in most instances, detectable by visual inspection, but such defects as slag inclusions, lack of fusion, lack of penetration, shrinkage cracks, or crater cracks are seldom visible to the naked eye. (See Fig. 5.) All are high stress raisers that will lead to trouble if allowed to remain in the weld zone during service.

Undercut, overlap, slag inclusions, lack of penetration, and lack of fusion in a part, when put into service, may be the beginning of a fatigue crack that will lead to blowout. Shrinkage cracks and crater cracks will progress in service and result also in ultimate failure.

Preventive inspection by the magnetic particle process, performed during fabrication, will make possible location of these defects and their elimination by reworking, will make careful welders out

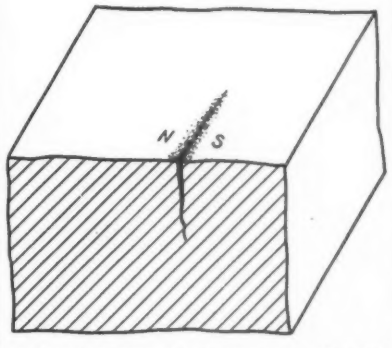
FIG. 1.



PATH OF MAGNETIC FLUX IN THE VICINITY OF A SURFACE DEFECT.

PATH OF MAGNETIC FLUX IN THE VICINITY OF A SUB-SURFACE DEFECT

FIG. 2.

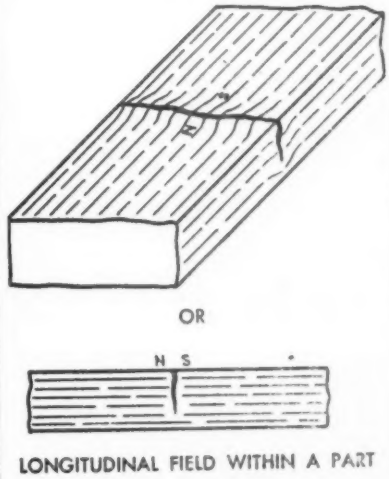


POWDER BUILD-UP ALONG CRACK

FIG. 3.

CIRCULAR FIELD WITHIN A PART —LONGITUDINAL DEFECT

FIG. 4.



LONGITUDINAL FIELD WITHIN A PART —TRANSVERSE DEFECT

of indifferent ones, and will prevent many costly blowouts.

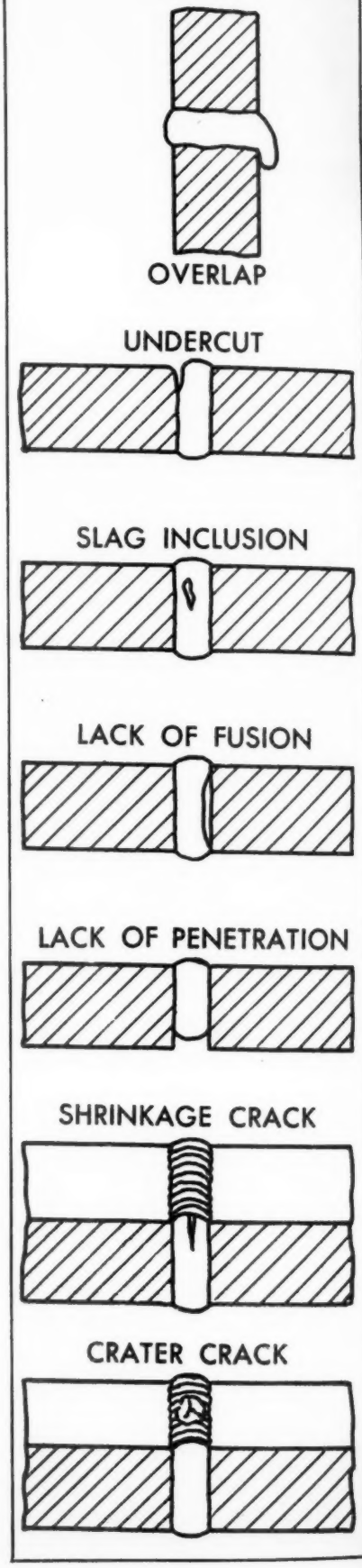
Lines exposed to the surface across ravines, creeks, and rivers may be periodically inspected for fatigue cracks occurring from the high stress loads imposed by high water.

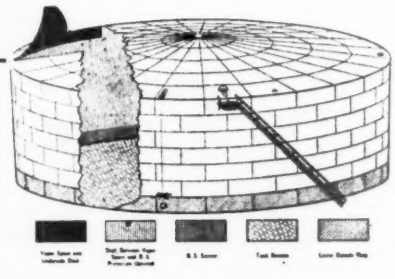
In the pumping station, it is sometimes practice to discard arbitrarily certain parts after set periods of service. An example of this type of part is the king bolt. Such a practice likely developed from the lack of an efficient method of inspecting these parts during the overhaul period.

A recent inspection by the magnetic particle method on 10 king bolts so discarded revealed all to be perfectly sound and free from any sort of defect. Six of these bolts had been removed on the day of inspection, after 4 years' service, whereas the other 4 were dug out of the scrap pile. The latter were heavily rusted and had lain in the pile for an indeterminable time. All 10 were returned to service, incidentally.

During this same inspection, 2 side rods were inspected. One had a fatigue crack that had progressed sufficiently to be detected visually (Fig. 6), and had been removed from service for that reason. The other rod had been forge-welded in the webb at the foundry, at an apparently too low temperature, resulting in a lack of fusion, and the crack had opened up during service (Fig. 7). This was not detectable by visual inspection, however. The service life of both rods after being repaired was 25 years. The first rod having the fatigue crack was salvaged by grinding out the crack completely and machining off to the depth of the grinding. (Fig. 8.) Magnetic particle inspec-

FIG. 5.





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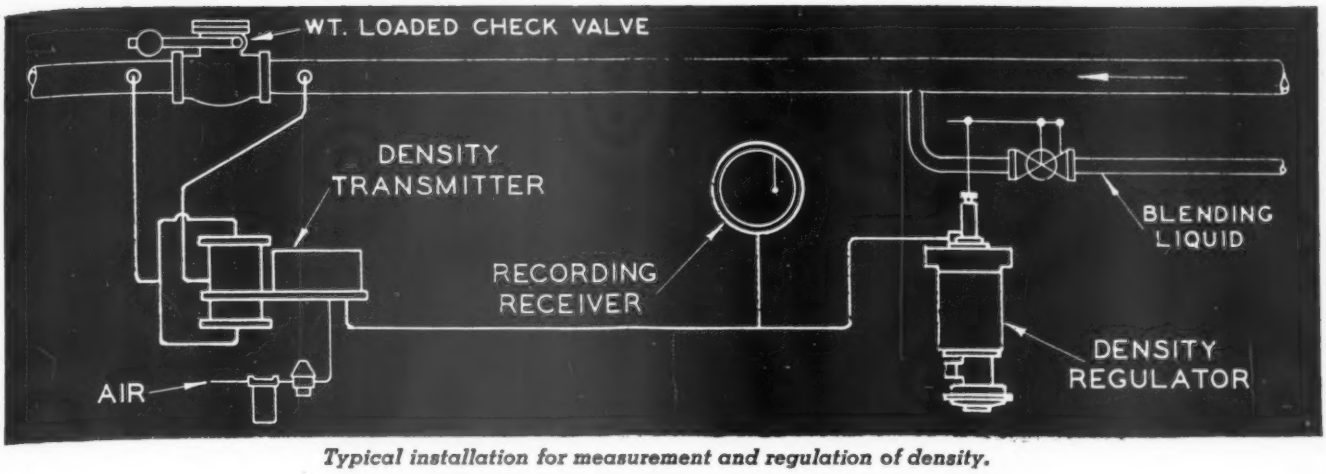


Typical installation for measurement and regulation of density.

REPUBLIC PNEUMATIC LIQUID DENSITY TRANSMITTERS

The Republic Pneumatic Density Transmitter employs the force-balance principle to establish an air pressure which varies proportionately to variations in density of a liquid flowing in a line. The air pressure is therefore a direct measure of the density and can be conducted to a remote location by means of small tubing. A receiver gage connected anywhere in this transmission line will show the variation in the density, and may be used as the impulse for actuating an automatic regulator.

The Transmitter can also be furnished for direct submersion in a tank or vessel, either open to atmosphere or under pressure.

OPERATING ADAPTABILITY

RANGE—Transmitters can be furnished for liquids of densities from 0.5 sp. gr. (compared to water at 60° F.), to the heaviest liquid known.

OPERATING RANGE—Can be as small as 0.05 sp. gr. and this may be from any base density. For example, range may be 0.6 to 0.65; 2.5 to 2.55; etc. Maximum spread may be any amount necessary; e. g.—0.6 to 3.0; 0.8 to 3.5; etc.

RANGE CHANGE—The base density may be changed approximately 3 to 1 by shifting the operating range adjustment weight. For example, the instrument may be built to show a change of 0.05 (or other range spread) above base densities from 0.6 to 1.8, the value of the base density being determined by the position of the adjustment weight.

The spread of the operating range can be changed approximately 3 to 1 by changing the position of the reaction diaphragm along the weighbeam. The base of the reaction diaphragm chamber is slotted to facilitate this change. The spread may be changed approximately 10 to 1 by changing the size of the reaction diaphragm. This change is easily made by changing the diaphragm plates, thereby changing the effective area of the diaphragm.

OPERATING PRESSURE—The standard transmitter is designed for operating pressures to 150 psig. Special designs are available for pressures up to 7500 psig.

The Republic Liquid Density Transmitter with cover open.

PERFORMANCE

ACCURACY—Output pressure vs. measured density is guaranteed accurate to ½ of 1% of range spread.

SENSITIVITY—Since the ratio of available force to effective friction is very large, and the motions required for complete operation are very small, the net dead spot in the mechanism is so small as to be undetectable by ordinary means, being less than 1/20 of 1% of minimum range spread of 0.05 sp. gr.

RESPONSIVENESS—At recommended sampling velocities, 90% of a change in density will register at the transmitter output in 15 seconds.

WRITE FOR BULLETIN NO. 44-10

REPUBLIC FLOW METERS CO.

2240 Diversey Parkway, Chicago 47, Illinois

tion was carried out at intervals during the grinding process until no further powder indications were obtained along the crack zone. Plenty of safety factor remained even after the surface was machined off, and the rod was scheduled to be returned to service. The other rod had to be replaced as salvage was impossible.

In another inspection, performed on a vee type compressor engine, several cylinder pot flanges were found to have fatigue cracks dangerously close to the failure point. In fact, the inspection was prompted by one of the cylinder pots failing from such a crack and blowing out through the roof of the station. Fortunately no injury to personnel occurred.

Other inspections have revealed fatigue cracks in compressor housings, flywheels, crankshafts, pistons, wrist-pins, connecting rods, and other reciprocating parts of the engine.

Crankshafts may be inspected before grinding to determine whether fatigue cracks are present, and if so whether they go deeper than the grinding tolerance. In this way the costly job of grinding may be eliminated, if such is the case. By the same token, such shafts if periodically inspected for fatigue cracks many times may be salvaged by grinding the crack out before it has progressed below the grinding tolerance. Other parts of the engine likewise may be salvaged when inspected often enough to find the fatigue crack in its incipient stage.

High pressure valve bodies also may

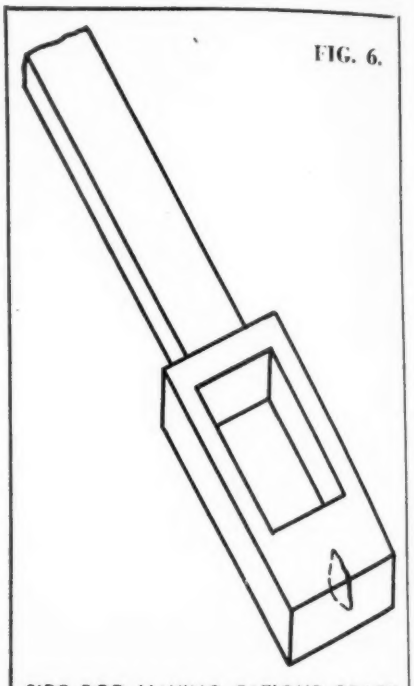


FIG. 6.

SIDE ROD HAVING FATIGUE CRACK —CRACK APPROXIMATELY 1½ IN. ON EACH FLAT, GOING INTO METAL APPROXIMATELY 1¼ IN.

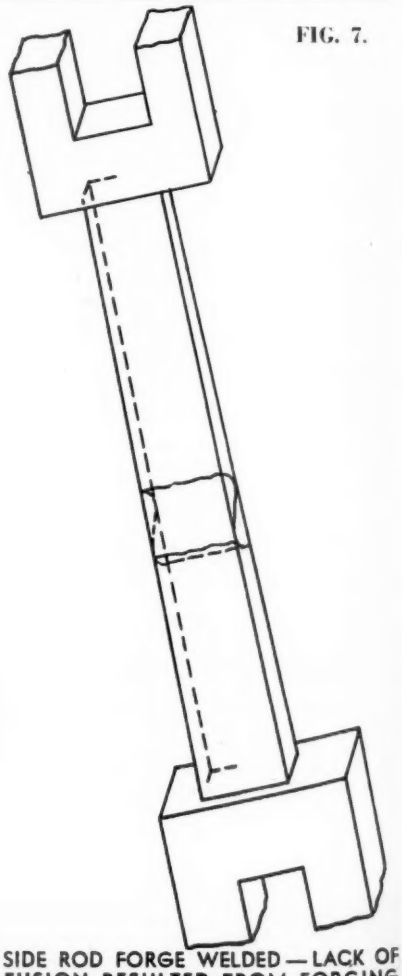
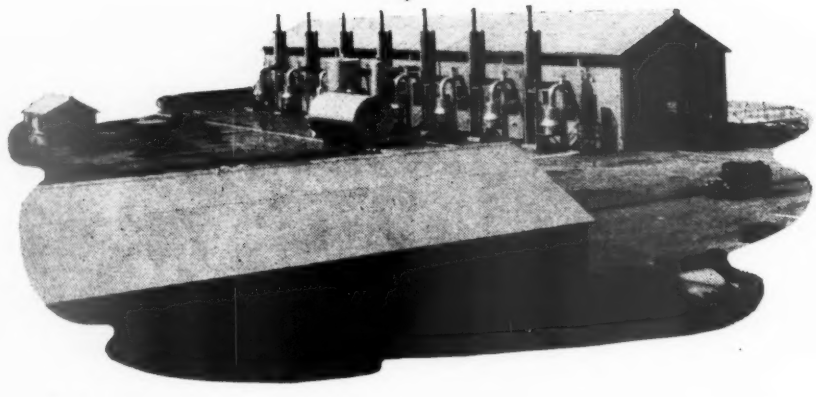


FIG. 7.

SIDE ROD FORGE WELDED — LACK OF FUSION RESULTED FROM FORGING TOO COLD AND CONSEQUENTLY IT OPENED UP TO SOME EXTENT IN SERVICE

BRADEN SECTIONAL STEEL BUILDINGS



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SHEEHAN PIPE LINE CONSTRUCTION COMPANY

JOHN B. SHEEHAN, *Manager*

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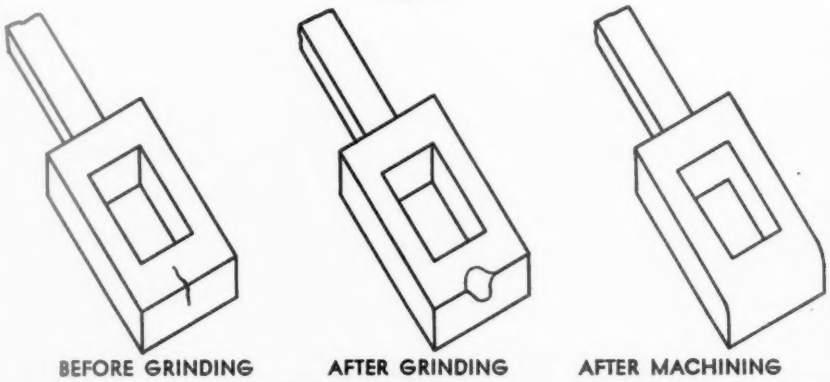
TULSA, OKLAHOMA

FIG. 8.



be inspected by this method for fatigue cracks or inherent defects. In a recent refinery inspection a large high pressure valve that previously had failed was checked. It had been removed from servive after the failure, and the extensive fatigue crack welded. Inspection of the weld zone proved it sound, but on inspecting the opposite side an extremely bad fatigue crack was revealed by powder indication. Repair was impossible and the valve had to be scrapped, but another failure was prevented. (Fig. 9.) This crack was invisible to the naked eye even after sandblasting. Another pressure valve was found to have an extensive longitudinal crack after being in service only a short time, and again the crack was unnoticeable on visual inspection.

Because of the extremely heavy demand on the facilities of the pipe line industry in the face of acute shortages of replacement parts and manpower, failures in the field or in the pumping station can be highly costly and time-consuming. Such failures, of course, are costly and dangerous at any time, but in addition may now vitally affect service to war industries and to the fighting effort.

★ ★ ★

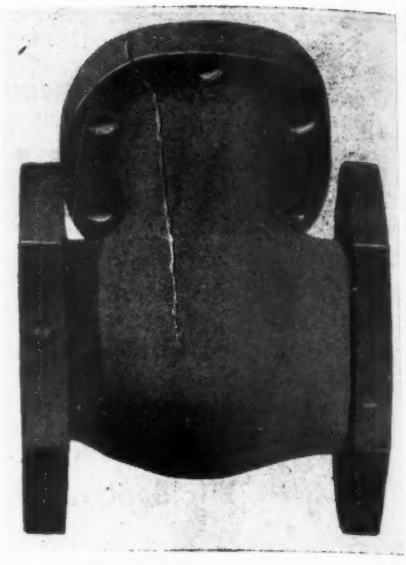


FIG. 9. Fatigue crack in large high pressure valve.

90-mile line

A new outlet for gas from Panola County, Texas, is under way with the construction by Lone Star Gas Company of a 90-mile line from the field to its Trinidad, Texas, plant. The carrier will be several months in construction.

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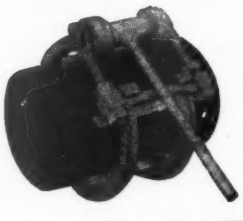

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Hand Rugs	Canvas Paint Rugs
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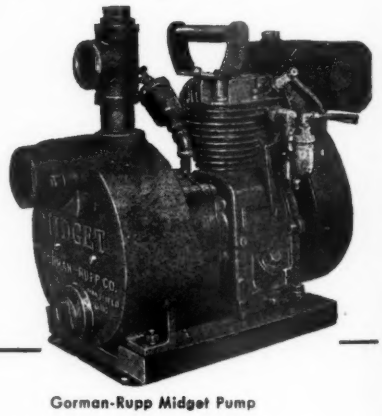
Pipe Cradles	Wire Brushes



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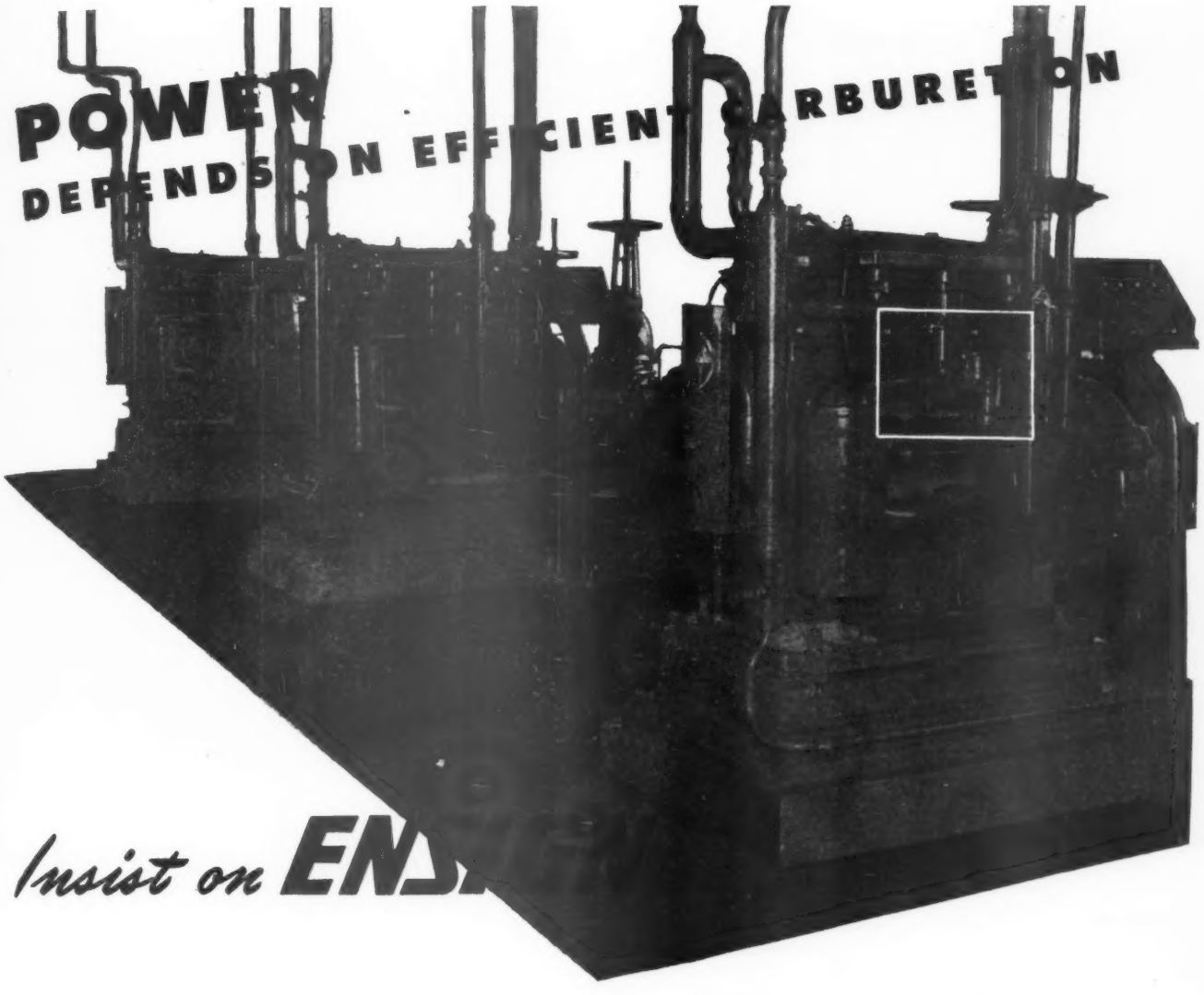
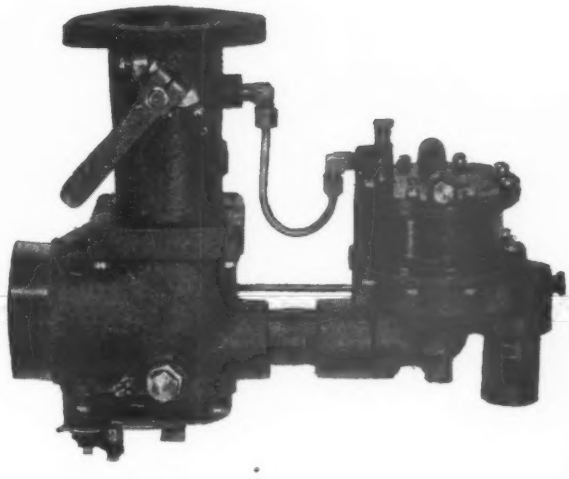


The picture above shows ENSIGN Carburetion Equipment installed on engines at the Erath Plant, largest cycling plant in the world, where 220 million cubic feet of gas is processed daily.

This is only one example of the universal use of ENSIGN equipment. In every industry, in war or peace, wherever peak production demands efficient power you'll find ENSIGN.

ENSIGN production today is almost entirely for war needs, but a limited supply of ENSIGN Carburetion Equipment is available for other uses. Repair and replacement parts can be furnished promptly.



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Many engineers have found they can use thin wall pipe by using WEDGE Split Chill Rings with the patented SPLIT Feature for welding joints. They REINFORCE the joints and make them STRONGER than the pipe—in case of settling or strain the reinforced joints won't leak or break.

The unretouched photos show two sections of pipe, one with and one without the WEDGE Chill Ring. Note that the WEDGE Chill Ring assures 100% PENETRATION of the ENTIRE circumference of pipe. Use WEDGE Chill Rings and WELD refinery and line pipe joints.

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SAVE MONEY

BUILDS NOVEL LINE-UP CLAMP

By **O. C. IRVINE,** United Gas Pipe Line Company

EXCLUSIVE JULIUS LAENGER, maintenance crew welder for United Gas Pipe Line Company at Latex in United's Shreveport district, liked the idea of completing a weld in one operation, and the line-up clamp—more appropriately, a saddle or cradle—that he built of scrap material was the result of his efforts to put his idea into effect.

Although most welders probably have no objection to conventional types of line-up clamps that require removal following tacking before completing a weld to join two lengths of pipe, Laenger's device has certain innovations and advantages that will appeal to others like himself.

The working principle is rather clearly shown in the accompanying pictures, its chief advantages being the long cradle rests provided for ends of the pipe to be welded and the clearance it gives the welding torch, permitting a finished weld without removing it from the pipe.

By leaving the clamp in place until the weld is completed, there is no danger of a broken tack weld caused by movement or slippage of one of the joints of pipe.

The clamp pictured is for 4-in. pipe. It was made of a piece of junked 6-in. pipe, approximately 8 in. long, cut in half endwise to form the cradle rests. The two halves are joined together on either side by pieces of 1-in. reinforcing rod, which are bent at right angles and allow sufficient space for running a bead completely around the pipe.

The pin and pin section, made of metal strips cut out of discarded line pipe, are high enough to permit driving the pin through slots provided for it to clamp the pipe securely.

With the end of the pipe centered in the space between the two cradle sections, the end of the pipe to be welded on is placed in the other cradle section, thereby providing the proper welding alignment. ★★★

This group of pictures illustrates the working principle of the line-up clamp.

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VOCATIONAL CLASS PROCEEDINGS

INSTALLMENT No. 6

EXCLUSIVE ▸ **The Pace well of Sun Oil Company.** The Sun Oil Company executives in January, 1938, decided to follow through the experiment with the Gulf-Jarvis well. They decided to drill a well as close to production as possible. If oil was found, it was to be produced as an oil well; but if no oil was found, it was to be completed as a salt water disposal well.

The well was completed in the following manner: 7-in. casing was set to a depth of 3722 ft. in the Austin Chalk. The top of the Woodbine sand was found at 3738½ ft. The total depth was 3739 ft. The well was swabbed without results and was then pumped with an individual unit for 10 days. Oil failed to make its appearance, and the well was temporarily abandoned on February 2, 1938.

On April 28, 1938, The Sun Oil Company received a permit from the Railroad Commission to undertake an experiment in disposing of salt water produced from their Pace "B" lease in the Woodbine sand in the Pace 38 well. In their application for this permit, the Sun Oil Company stated that this well was located in Smith County, Juan Vargas Survey, outside and west of the present oil production. Pace B-36, the nearest producing well, was located 935 ft. southeast.

The Sun Oil Company deepened Pace B-38 to a depth of 4007 ft. or 26 ft. below the lowest sand encountered. Fresh water was used for drilling fluid.

The preparation for injection was simple. The well was electrically logged and was reamed to 3804 ft., with the size of the hole from 5 in. to 9 in.; 145 ft. of blank 5½-in. pipe was cemented, after the hole was bridged at 3805 ft. This pipe was extended 59 ft. up into the 7-in. pipe and a cut of 86 ft. of Woodbine and Austin Chalk section was taken. The liner was cemented with 50 sacks of cement and 2½ per cent Aquagel. After the calculated annular space between the casing and liner, as well as between the liner and the sand was filled, the remainder of the cement was squeezed into the sand.

On May 16, after 3 cement jobs, a satisfactory shut-off was obtained and the hole was then underreamed to 9 in. from 3808 to 3973 ft. This work was completed on May 22, 1938. The 7-in. casing was brushed for one day and the well was then swabbed and bailed for 3 days. The water was tested clear on May 28, with 33,000 ppm. of chlorides.

Tubing of 2 in. diam. was run with a disk in the bottom and the packer was set at 3600 ft. with an opening in the tubing above 3600 ft. Salt water was run into the annular space between the tubing and casing until clear salt water appeared at the surface from the 2-in. tubing. The disk was then broken and the filtered but untreated water was run into the well on June 2, 1938, at a rate of 46 gal. per min. at 26-in. vacuum.

Filtered water was run into the well from June 2 to June 25, 1938. At this time it was found that the sand was clogging and injection was discontinued; 40,000 bbl. had been injected.

From June 25 to September 16, experimental chemical work was done on the water and the original closed system was changed to an open system. The main trouble in the closed system was found to result from a change in the iron compounds in the water, which caused a clogging of the sand face.

Beginning on September 16, the water to be injected was aerated, passed through a settling basin, filtered, and then injected into the well. Changes in equipment in the well included the replacement of all steel pipe by Durolined pipe. A 3½-in. Durolined string of tubing with a packer at the bottom was used. This change to lined pipe was necessitated by the increased corrosive action of the salt water caused by oxygen from the air.

On October 30, the well had injected 70,805 bbl., which was a greater rate than the salt water production rate of the Pace B lease.

The Sun Oil Company then made application to the Railroad Commission to inject water from other leases into this well. Permission to do so was granted, and arrangements made to take water from other Sun leases.

From September 15, 1938 to April 17, 1939, 450,000 bbl. of salt water were injected. At this time the well began plugging. On March 17, 1939, the tested rate was 88 gal. per min. at 27-in. vacuum. By April 25 the rate was 76 gal. per min. at 0 lb. pressure. The well was treated with a dilute solution of acid (10 per cent hydrochloric) without removal of the Durolined tubing. No change was noted. On May 1 the tested input rate was 63 gal. per min. at 10 lb. pressure. On May 3, 1939, the well was pumped with Halliburton equipment at 325 lb. pressure but there was still no improvement. A total of 525,000 bbl. of water had been injected up to this time.

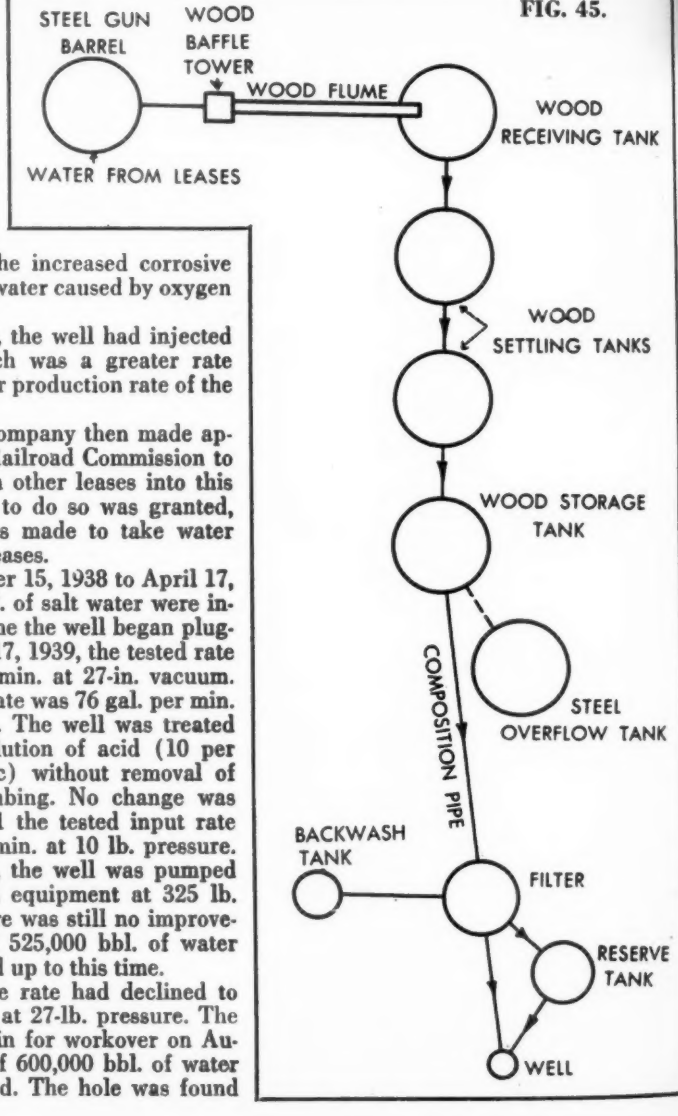
By July 26 the rate had declined to 40 gal. per min. at 27-lb. pressure. The well was closed in for workover on August 1. A total of 600,000 bbl. of water had been injected. The hole was found to be bridged at 3833 ft., leaving 13 ft. of very poor sand exposed. The well was cleaned out and the 3½-in. Durolined tubing was replaced with 4-in.

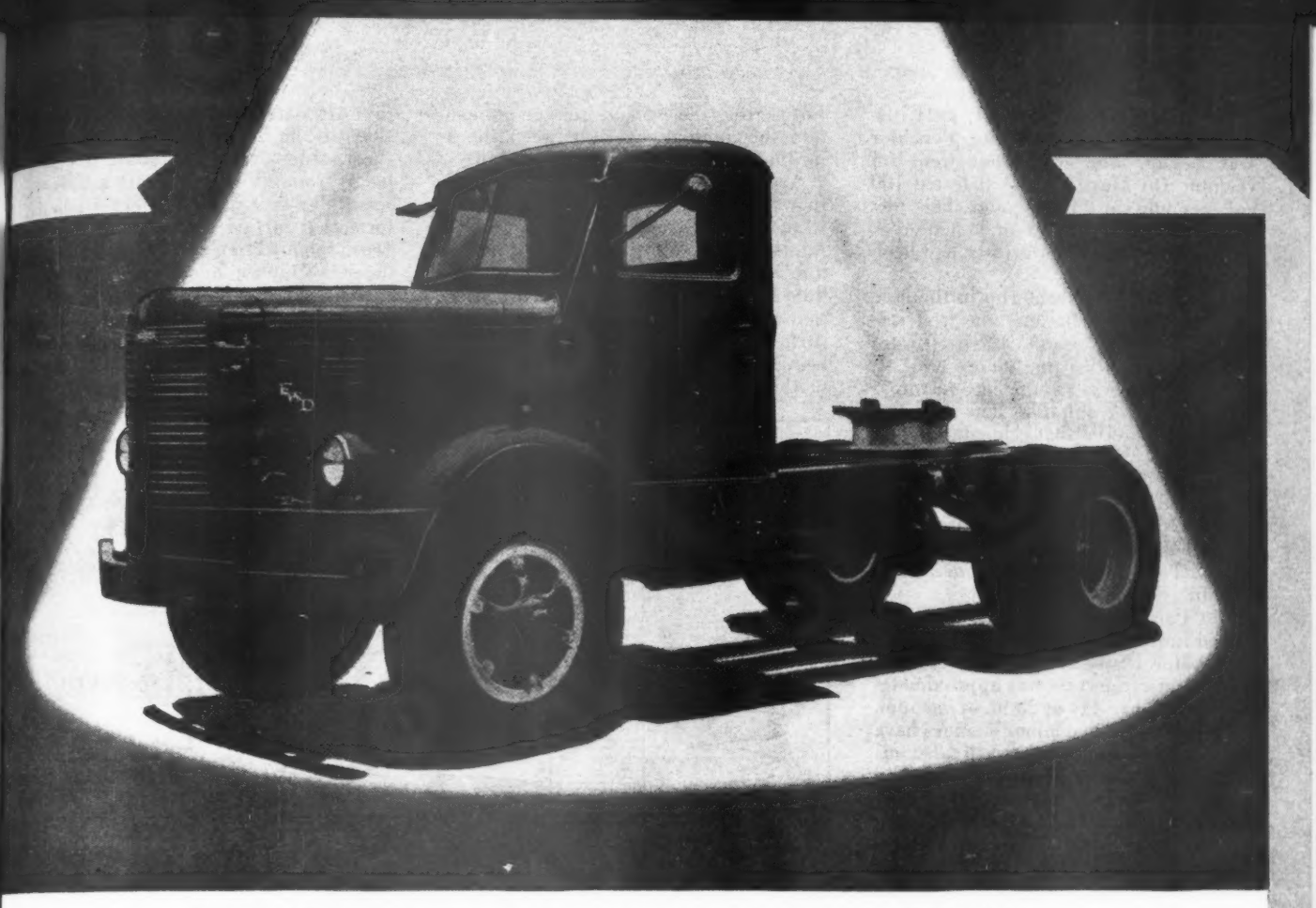
Injection was begun on August 13, 1939. On September 8 the tested rate was 66 gal. per min. at 27-in. vacuum. On May 23, 1940, the sand was replaced in the filter. A total of 1,210,000 bbl. of water had been injected up to this time. The tested rate on May 6, 1940 was 90 gal. per min. at 26-in. vacuum.

The well in early June showed signs of plugging. On June 7, 1940, the well was treated with liquid chlorine to open it up. This treatment was very successful. It tested 90 gal. per min. at 29-in. vacuum. This "slugging" with chlorine gas was continued until the well was sold to the East Texas Salt Water Disposal Company on April 1, 1943.

In June, 1940, a 12,000-bbl. asphalt pit was placed in service. A second filter was installed in January, 1941. A total of 1,956,000 bbl. of water had been injected

FIG. 45.





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up to that time. On April 21, 1941, the treatment of the water with Penchlor was begun. The well soon went off vacuum. On May 24, 1941 it tested 100 gal. per min. at 2-in. vacuum. This was not attributed to the use of Penchlor. A total of 2,366,000 bbl. of water had been injected.

A measuring line was run in the hole on June 30, 1942, because the well was refusing to take water. Cavings were found to have filled the hole to 3847 ft. The filter bed was examined and found to be full of iron sulphide. The sand and gravel also showed that cementation had occurred.

In July, 1942, the Durolined tubing was pulled and the well was cleaned out with a Cavins bailer and acidized with mud acid. The filter charge was replaced. Total injection then was 3,985,000 bbl.

The Pace Disposal System was purchased in April, 1943, by the East Texas Salt Water Disposal Company. At that time the injection rate was approximately 4500 bbl. per day at 28-in. of vacuum. Since that time some minor changes have been made. A second backwash tank was erected to give additional water capacity for backwashing. A rectifier and a set of electrodes were installed to aid in treating the water.

With the aid of an injection pump the maximum injection per day was 9890 bbl. at 200-lb. pressure. The well as of March, 1944, had injected a total of 7,271,627 bbl. of water since June 2, 1939. Water is now being injected at the average rate of 8,400 bbl. per day or 3,166,000 bbl. per year.

Magnolia Petroleum Company. This company completed J. R. Wright 43, Juan Vargas Survey, Joiner area, Smith County, primarily as a salt water injection well. This project was one of the most elaborate yet undertaken in the field, both from a surface and subsurface standpoint.

In completing J. R. Wright 43, the company took into consideration various conditions and factors that had affected injection operations in other wells. The 7-in. casing was cemented at 3730 ft., but below this string a 10-in. hole was drilled to 3893 ft. with expansion reamer. A 5-in. alloy liner was set on a packer near the shoe of the 7-in. casing and run to 3860 ft. This liner was perforated except for a short section below the shoe of the 7-in., and the hole below these slots gravel-packed. A total of 660 gal. of gravel was required to fill the hole around the liner and the 63 ft. of open hole below the liner. A temporary, pyramid-shaped plug was placed in the liner immediately below the 3 slots, to force the gravel outward into place. Oil was pumped into the space adjacent to the shoe of the 7-in. casing, filling the area behind the short blank section of line and that above the 3 slots used for passing the gravel. The cushion of oil thus trapped prevents salt water from contacting the steel casing during injection. A full string of 4-in., cement-lined tubing was run and anchored with a packer near the top of the 5-in. alloy liner. Before setting the packer, oil was pumped into the annular space between the 4-in. lined tubing and the 7-in. casing.

A departure from the usual completion practice was the running of 1000 ft. of 1¼-in. cement-lined tubing with 3 joints of 2-in. alloy tubing on the bottom of this short macaroni string. The fluid level of the salt water during injection was slightly below 1000 ft. from the surface, the 3 joints of 2-in. alloy tubing being enough to handle the slight fluctuations in the fluid level and to prevent the salt water from contacting the outside of the lined 1¼-in. tubing. The short string of 1¼-in. tubing has a capacity roughly equal to the amount of salt water that will be injected into the formation in this well, this balance between the injection rate and flow through the small tubing being important.

If no small tubing was used and the normal fluid level should remain at about 1080 ft., considerable turbulence would be created by "dropping" the salt water into the wellhead allowing it to fall down

FIG. 46. Sun Oil Company H. A. Pace B No. 38.

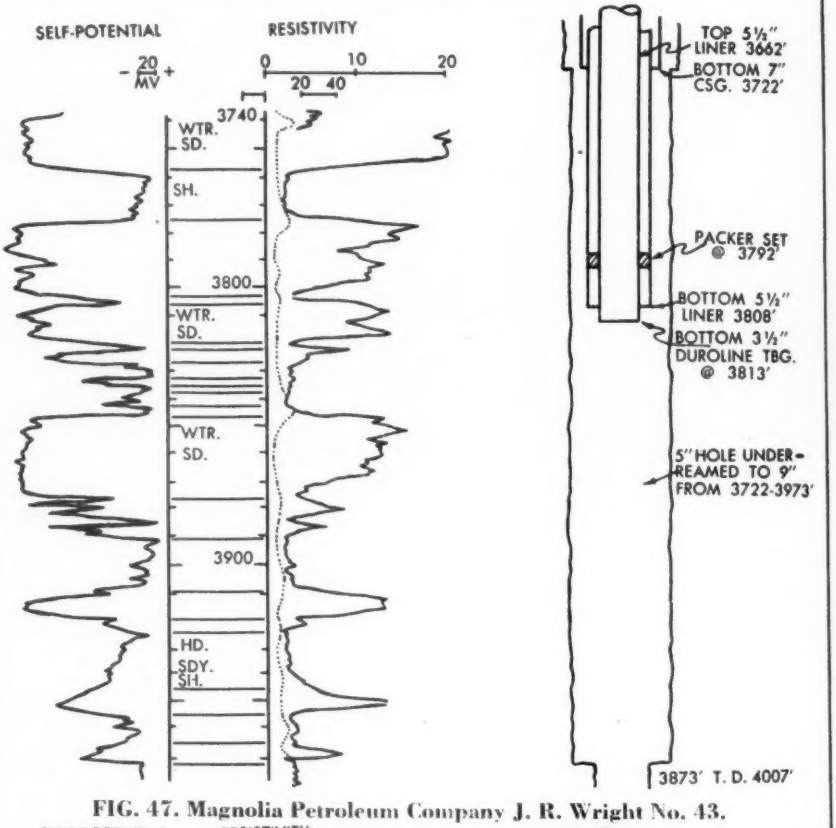
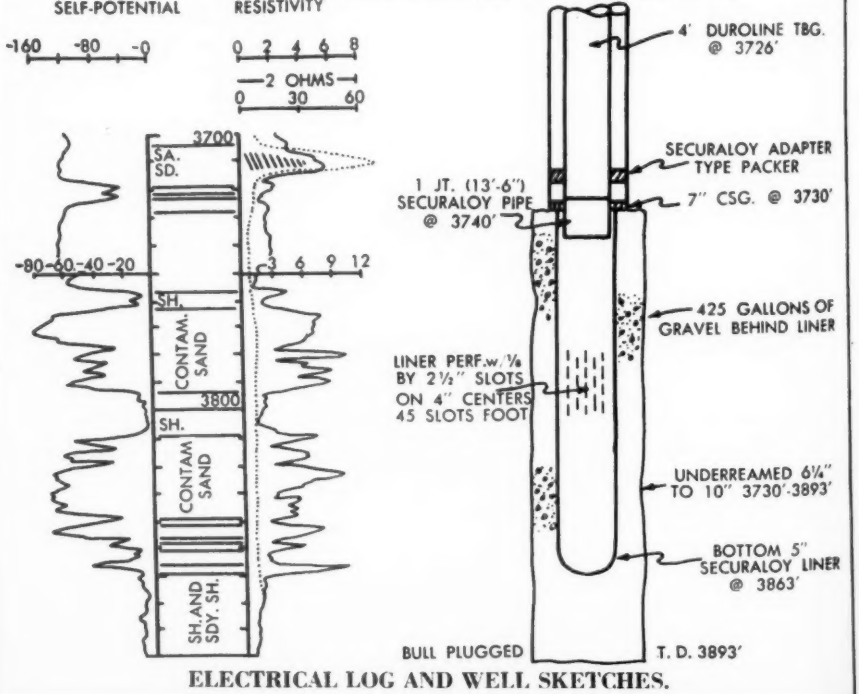


FIG. 47. Magnolia Petroleum Company J. R. Wright No. 43.



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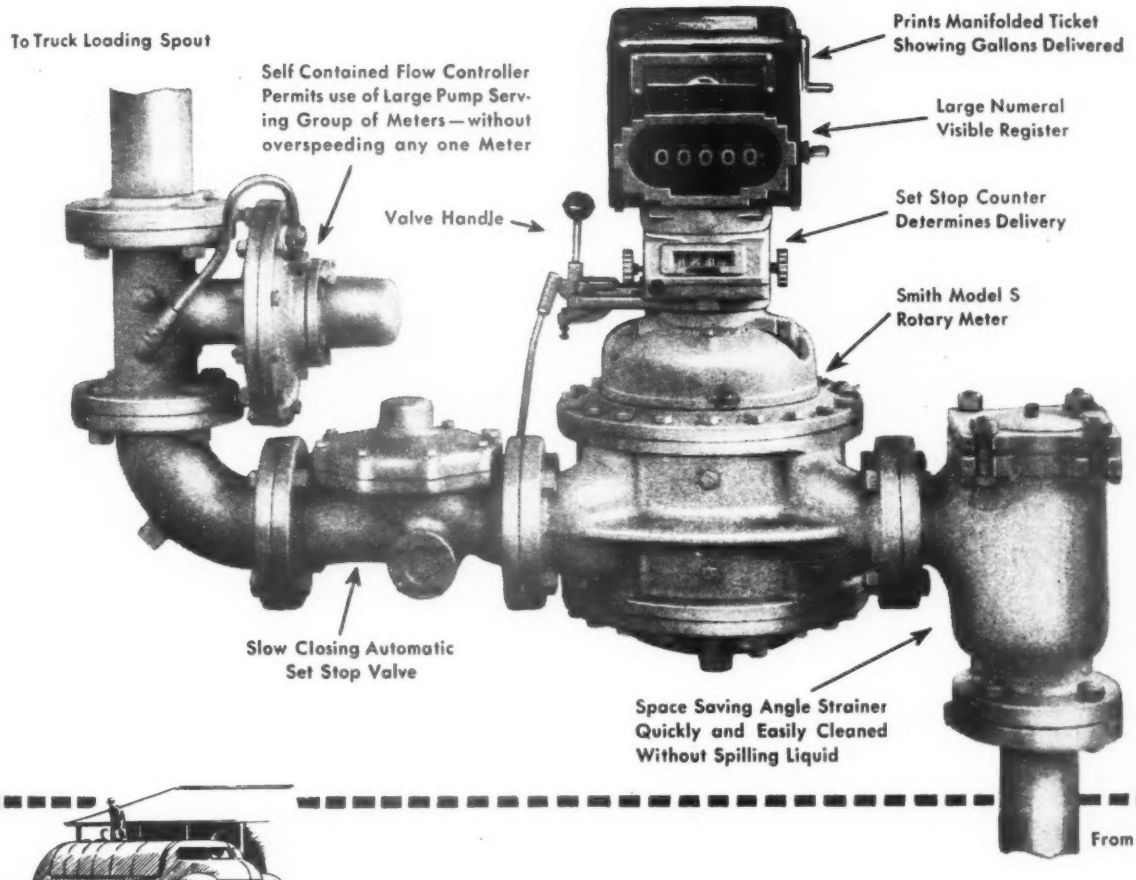
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Space Saving Angle Strainer Quickly and Easily Cleaned Without Spilling Liquid
From Pump

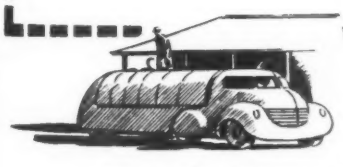

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FIG. 48.

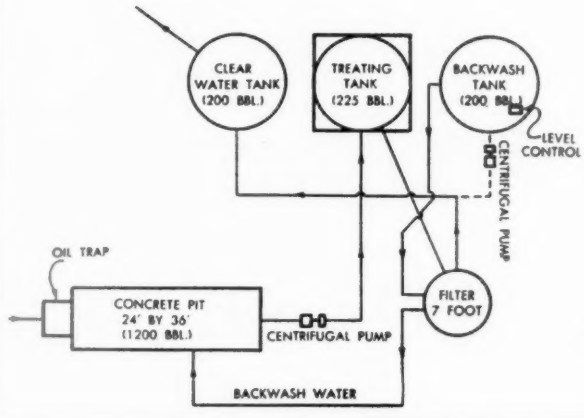


FIG. 49.

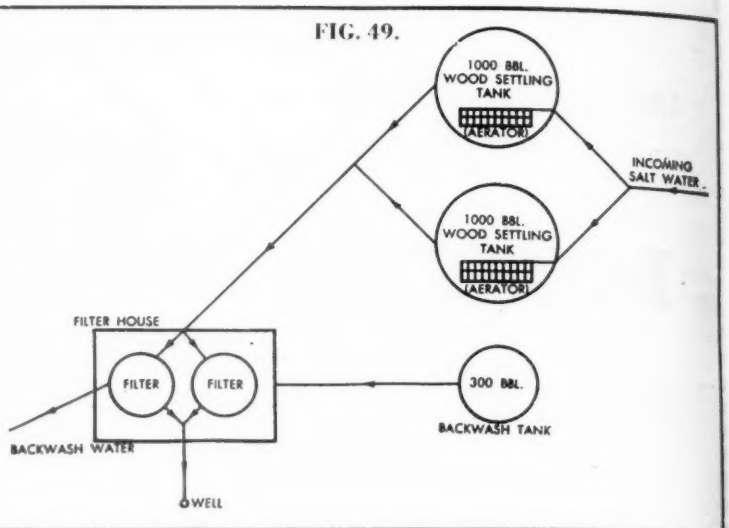
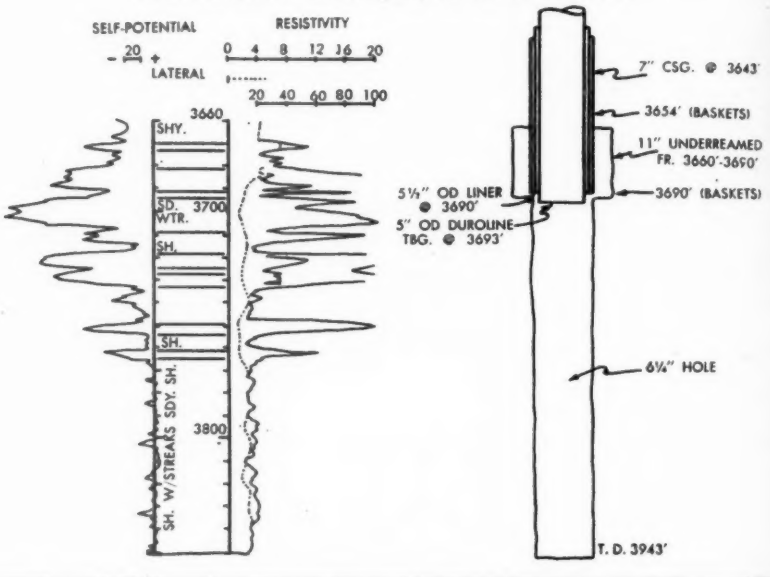


FIG. 50. Ohio Oil Company M. M. Cross No. 9.



the 4-in. lined tubing and strike the more stable fluid below 1000 ft. The flow through the 1¼-in. tubing, though still in the experimental stage, will give an almost uninterrupted flow from top to bottom. Two bradenheads are used at the surface, one to pack off between the 7-in. and the 4-in. tubing, and one to pack off between the 4-in. and the 1¼-in. tubing. The arrangement permits injection of about 4000 bbl. of salt water daily. Thus the normal flow is through the 1¼-in. lined tubing, the 3 joints of 2-in. alloy pipe, the 4-in. lined tubing, the alloy liner, the gravel, and into the water formations below the oil producing level.

The surface equipment used by Magnolia Petroleum Company is similar to that used by Tide Water Associated Oil Company. The system of handling the salt water ahead of injection is essentially an accelator or sludge blanket process, in which the equipment provides for aeration of the brine by forced draft, treatment with a coagulating agent, contact with precipitated sludge in the reaction tank, and filtration of the treated brine. Chemicals ordinarily used include alum, lime, and hypochlorite.

The flow of the salt water is through a concrete oil trap, through a 24-ft. by 36-ft. concrete settling pit, to a small centrifugal pump on the ground level, to the top of a 250-bbl. treating tank, through a 7-ft. filter, to a 200-bbl. clear water tank, and into the injection well nearby. The flow from the top of the treating tank to the wellhead is by gravity. A 200-bbl. elevated backwash tank is used, the backwash water being returned to the concrete pit for regular treatment. The plant has a capacity of 4000 bbl. per day.

Ohio Oil Company. This company has been injecting salt water into M. M. Cross 9, Faulks Survey, Joiner area, Cherokee County, this project being a converted oil producer that originally was completed at about 3680 ft. with 7-in. casing cemented above the oil sand. For injection purposes the well was drilled to 3785 ft., a 5-in. liner or short string cemented at 3690 ft., and a string of 3½-in. cement-lined tubing run to the bottom of the liner. The cumulative amount of salt water injected to the end of 1943 was 3,301,048 bbl., injection having been largely by gravity.

The first twin injection project in the field was undertaken by the Ohio Oil Company, with the conversion of M. M. Cross 12 into an injection well. M. M. Cross 12 is a direct offset to M. M. Cross 9, and the same general surface facilities were used in preparing the salt water for injection. M. M. Cross 12, was an oil well, and carried a 7-in. oil string at 3624 ft. The well was deepened to 3828 ft., and a short string of 5½-in. casing was cemented between 3540 and 3680 ft. to protect formations immediately below the shoe of the 7-in. casing. A string of 3½-in. cement-lined tubing was run on a packer to a point near the bottom of the 5½-in. short string.

The company's aerating and settling unit is one of the most compact in the field. The incoming salt water passes through aerating troughs at the top of two 1000-bbl. wooden settling tanks, through the tanks, through two filters, and into the well under natural head. The receiving tanks are equipped with wooden conduits and baffles to obtain an increased settling effect. The tank outlets are 6 ft. from the bottom, the flow being into a common line to the filters. A 300-bbl. wooden backwash tank is elevated to permit gravity flow when backwashing the filters.

The Ohio Oil Company's first salt water injection effort did not prove entirely successful. An attempt was made to inject salt water into sands below the oil zone while producing oil from the well. This dual arrangement was carried on for a short time through the use of tubing packers, the oil having been produced through the tubing, and the salt water bypassed to the lower water sands. The salt water was injected from the surface through the annular space between the casing and the tubing, bypassed through the oil zone, and injected into lower water sands by an ingenious arrangement not made public by the company. A closed injection system was used, but the water sands apparently became clogged in a short time and only a small amount of water could be forced into the well. This unique injection plan was given up after a short period, and the well, J. H. Sharpe 21, Joiner area, restored to its status as an ordinary oil producer from sand around 3693 ft.

★ ★ ★

(Continued in an early issue.)

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1859

1868

1893

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G.E. vice president

Ralph J. Cordiner has been elected vice president and assistant to the president of the General Electric Company with general administrative duties as designated by the president, it has been announced by Charles E. Wilson, president. Cordiner has been assistant to the president for the last 18 months, since his resignation as vice chairman of the War Production Board.

A former member of the G-E Appliance and Merchandise Department, Cordiner has been continuously connected with the electrical industry since his undergraduate days at Whitman College in Walla Walla, Washington, when he was employed part-time as an electrical appliance salesman by the Pacific Power and Light Company. After his graduation in 1922 he was commercial manager of a division of that company, but within a year became connected with the Edison General Electric Appliance Company (Hotpoint), serving successively as northwest manager in Portland, and Pacific Coast division manager in San Francisco.

In 1932, when the heating device activities of Edison G-E Appliance were transferred from Chicago and consolidated with General Electric's merchandise department at Bridgeport, Cordiner was moved as manager. Two years later he became assistant manager of appliance sales for G.E. and in 1935 manager of the radio division. Subsequently, he became assistant manager of the appliance and merchandise department, and in 1938 was appointed manager, succeeding in that position Wilson, now president of the company. Cordiner resigned from G.E. in August, 1939, to become president of Schick, Inc., of Stanford, Connecticut, but left in December, 1942, when he entered government service as director general of war production scheduling and vice chairman of the War Production Board.

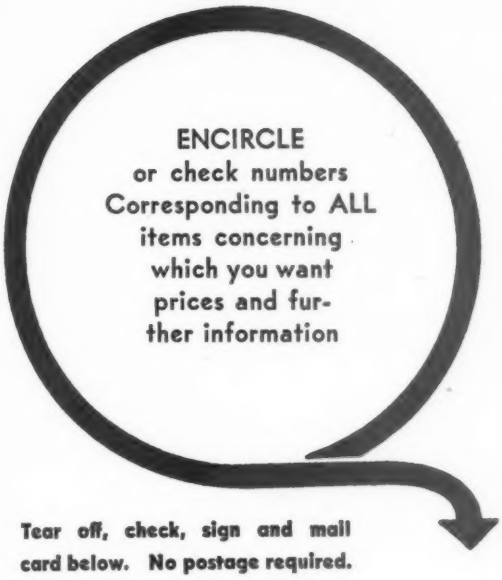
Manager N.Y. district

William Wagner has been appointed New York district sales manager for the Reading-Pratt and Cady Division of American Chain and Cable Company, Inc., with headquarters at 230 Park Avenue, New York City.

He succeeds E. Coit Magens who has been New York district sales manager for the last 25 years and who is now manager of the valve division, American Chain and Cable Company export department.

To hold gas course

The war committee on conventions of the Office of Defense Transportation has reviewed the past activities of the Southwestern Gas Measurement Short Course and has ruled that it does not come within the scope of the government restrictions on conventions. The ruling was made because the short course can in no way be considered a convention, but is a regularly scheduled educational project of the College of Engineering, University of Oklahoma.



PROMPT ATTENTION will be given to requests for literature, prices, etc. on products described in the NEW MACHINERY and EQUIPMENT Section, a regular feature of The Petroleum Engineer. Keep up-to-date on the many new products designed to make your work easier, more efficient.

MARCH
1945

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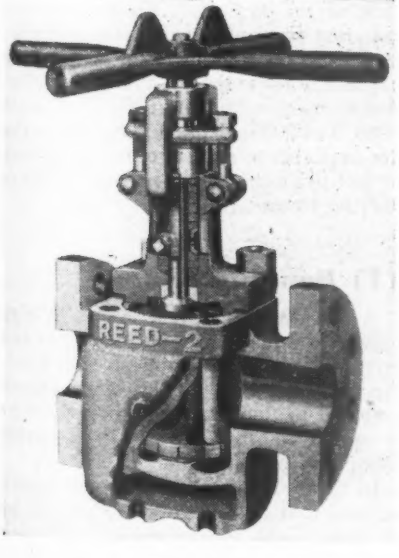
(1) *Jacketed steel valve*

Many materials such as tars, waxes, sulphur, asphalt, pitches, petroleum residues, molten caustic, etc., are very viscous and tend to harden and congeal at ordinary temperatures. These materials must be kept fluid for transmission through lines and fittings.

To meet the demands of these services Reed Jacketed Steel Valves have been developed and the effective jacketing design, plus the easy operating characteristics and cleaning action of the disks, assure dependable operation at all times,



according to the manufacturer. Reed valves do not require lubrication, and maintenance costs are a negligible factor, it is asserted.

Expansion and contraction, due to temperature changes, do not affect the action of the Reed valve disks, which are accurately guided by the disk holder, yet are free to float with respect to the holder and the body seat. This construction is assurance against sticking and the detrimental effects of expansion and contraction under temperature.

Reed Jacketed Steel Valves are interchangeable with wedge gate standard steel valves and are supplied with ASA standard for O. S. and Y wedge gate valves.

The manufacturer is Reed Roller Bit Company, Houston, Texas.

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Advancements in petroleum and plant equipment are being made rapidly. Keep abreast by making full use of *The Petroleum Engineer's* enlarged New Equipment Section.

All items are numbered. A business reply card requiring no postage if mailed within the United States is provided. Check or encircle the number on the card that corresponds with the product or products in which you are interested and drop it in the mail. Literature and prices will be sent promptly.

(2) *Control timer*

The new Reco Control Timer is designed to control manufacturing operations in which starting is initiated by momentary contact push button, stopping automatically at preset time.

The Reco can also be equipped with interlocking controls so that each operation must be completed in correct sequence before the next is begun. Failure at any point would post a signal and the timer would recycle automatically to starting position.

One of the many possible applications of the Reco timer is as an hydraulic press control in which pressure valves are shut off upon reaching a certain tonnage, holding the pressure for a predetermined time and signaling the operator.

The Reco timer is equipped with silver contacts and has a two circuit control. It has synchronous motor for operating on 115-volt 60-cycle a-c. current. When desired it can be equipped with additional circuits and arranged for other current specifications. The manufacturer is the Reynolds Electric Company, Chicago, Illinois.

(3) *Brown Radiamatics*

Five major improvements, just introduced in Radiamatics, will make this compensated radiation pyrometer secure against air and gases up to 1 lb. per sq. in. gage pressure at temperatures up to 250°F., it is announced by the Brown Instrument Company, Philadelphia.

The five improvements are: (1) Use of an adhesive sealing compound between the lens and mounting ring; (2) use of brass for lens retaining and mounting rings; (3) controlled torque is applied when assembling the lens retaining and mounting rings; (4) two spanner wrench holes in the lens mounting ring face have been replaced with a milled slot that avoids cutting through the ring face, and (5) use of a more positive sealing, with an improved adhesive, of the sighting glass located in the rear of the thermopile assembly.

Other improvements include use of aluminum instead of cast iron for the Radiamatic housing. This latter applies to Radiamatics shipped after March 1.

The Radiamatic, product of the Brown division of Minneapolis-Honeywell Regulator Company, is designed primarily to meet exacting demands of steel mills, metallurgical works, ceramic plants and related industries. The Brown Radiamatic consists essentially of a heat resisting lens, a compensator, and a thermopile. Energy radiated from the hot object being measured falls on the lens and is focused on the thermopile, which generates an e.m.f proportional to the object's temperature. The measurements are independent of ambient temperatures.

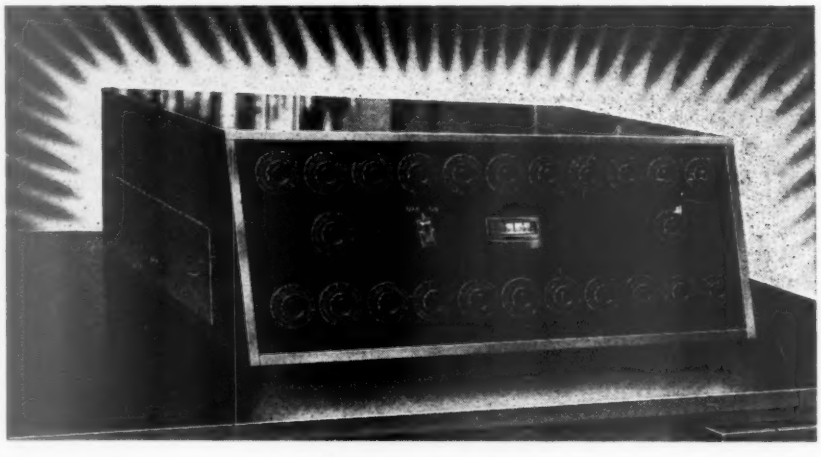
(4) *Spectro-Computer*

The Spectro-Computer, developed by Phillips Petroleum Laboratories, and designed and production-engineered by Engineering Laboratories, Inc., Tulsa, Oklahoma, is an instrument for infrared analysis and mass spectrometry.

The computer was developed for solving the simultaneous equations encountered in spectroscopic analysis and is manufactured in two sizes, one capable of solving 7 unknowns and one capable of solving a maximum of 11 unknowns.

The solution of these equations when performed mathematically requires many hours' time from highly trained engineers, yet by use of the spectrometer, operated by non-technical laboratory help, routine equations are solved in 5 minutes and the most complicated in a maximum of 15 minutes, it is stated. Control methods in manufacture of butadiene and aviation gasoline are speeded up and technical man-hours required in laboratory control are drastically reduced.

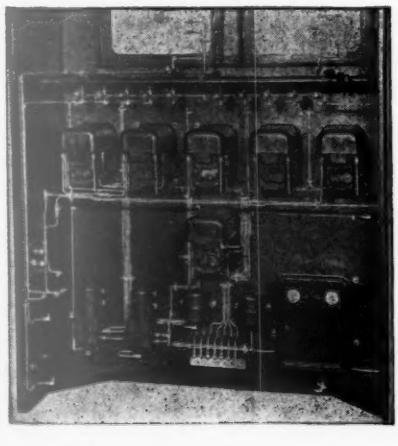
Phillips Petroleum Plains Butadiene Plant reports that "The spectro-computer has permitted the following realignment in analysis procedure: One man is now able to make all the computations of 24 hr. infrared analysis in the first 2 hr. of the day, making answers available for the morning operations-control meeting. This formerly required two chemical engineers the greater part of 10 hr. even using short cut methods and slide rules."



ELI spectro-computer

(5) *Boiler control panel*

Prefabricated boiler control panels that include all necessary connecting piping and electrical wiring for the operation of metering equipment and boiler control systems are now offered by Bailey Meter Company, Cleveland, Ohio, to simplify the user's problem of installation. These panels, which are factory fabricated and tested by experienced instrument mechanics, are said to save installation time, to insure the use of suitable materials, to reduce total installed cost, and to present a neat, pleasing appearance. All piping and wiring necessary for operation is installed as a unit according to a coordinated and prearranged plan instead of as piecemeal operations by various contractors in the field.



Small units such as valves, relays, switches, signal lights, and the more sturdy and light-weight instruments are mounted and connected ready for service. Heavy instruments or instruments having delicate mechanisms are shipped separately; but cutout spaces, drilling and all necessary connections are provided so that their installation in the field is a foolproof, quick and easy operation.

Connecting piping and electrical wiring are brought to convenient terminals, which are carefully tagged so that no time or effort is lost in connecting the prefabricated boiler control panel to the various factors that it controls.

(6) *Speed indicator*

Wherever machinery turns, there is the need for reliable, continuous, visual speed indication to gain advantages in lower costs, lengthened life for machinery and tools, improved quality, and in the assurance of safe operation.

Now a sturdy, accurate, low-cost electric speed indicator, developed by the Reliance Electric and Engineering Company, Cleveland, makes it possible to determine and to set operating speeds in a broad new field of applications, where the installation of such instruments was heretofore not economically feasible, it is stated.

The Reliance electric speed indicator, which gives accurate readings of speeds from 100 to 5000 r.p.m., consists of two units. The pickup unit, a miniature 6-pole alternator with a permanent magnet rotor, is mounted on the shaft whose speed is to be measured. The indicator, a permanent magnet, moving-coil type, meters the pick-up output on a 3¾ in. scale that covers 95 deg. of arc. The resistance of the indicator has been made sufficiently high so that the size or length of the leads connecting the units will have no effect on accuracy, and the indicator may be located at any distance from the pick-up unit. The indicator is not affected by other magnetic material, and there is no loss of accuracy due to length of service.

Reliance's 30 years' experience with variable-speed machinery drives has shown company engineers the need for such a compact, long-life production indicator, and they have built the utmost in sturdy simplicity into the mechanism, it is asserted.

Instantaneous and continuous speed indication is independent of the direction of rotation of the shaft. Pick-up windings are stationary, and there are no commutators or slip rings. No conduits are required, and lifetime lubrication further simplifies maintenance.

Special attention to flexibility of use has been given, also, in the physical design of the indicator. Fool-proof shaft coupling is provided, and the indicator may be bracket or panel mounted. Indicators are provided for full-scale deflection corresponding to 1500, 2000, 2500, 3000, and 5000 r.p.m., and special scales are available to read in other units, such as feet per minute, and process cycles of varying times.

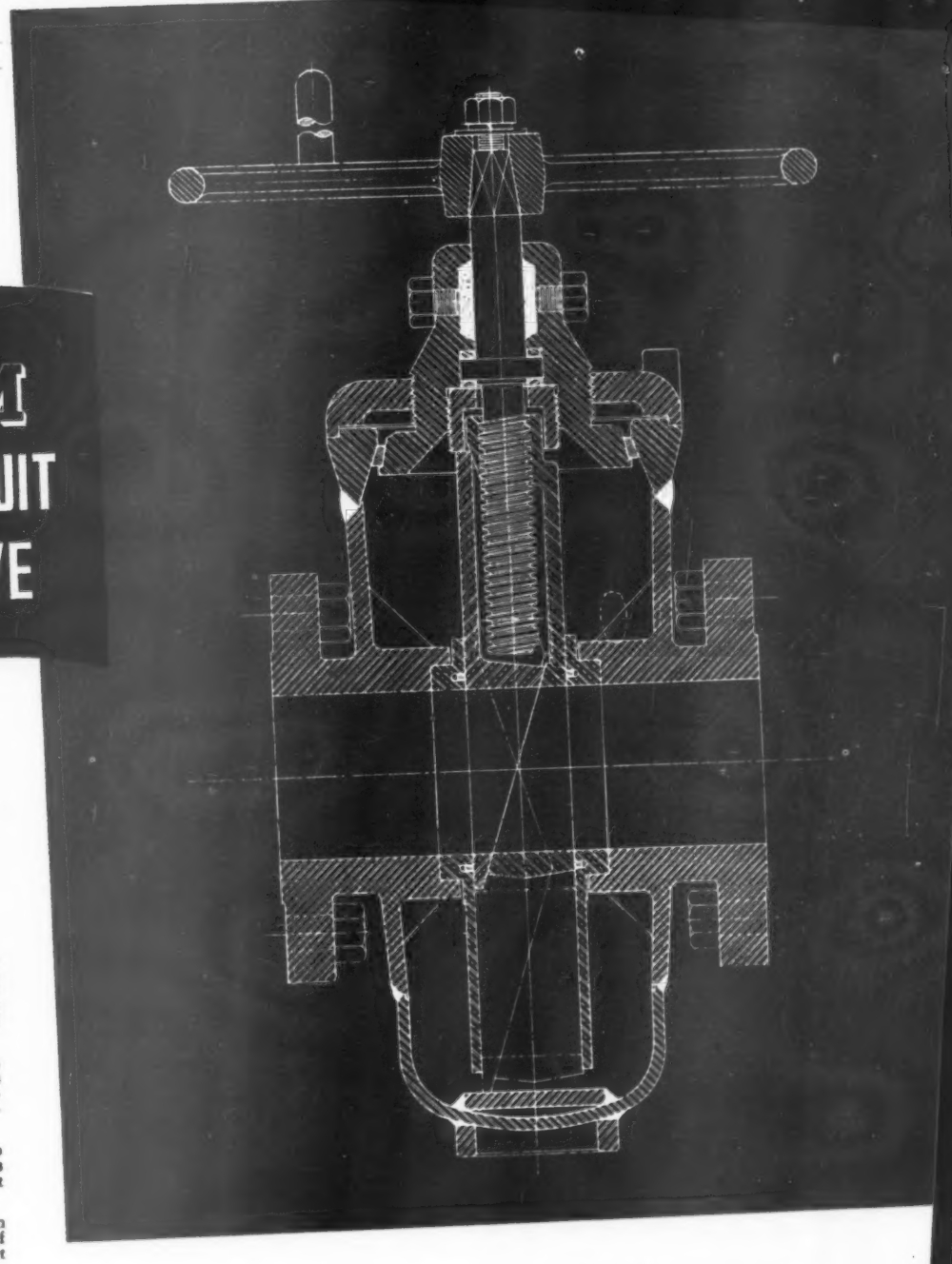
(7) *Bonding cement*

A new rubber cement, named Plastilock 500, a non-thermoplastic, water and aromatic oil-resistant adhesive for bonding metals, wood, plastics, and ceramic material to themselves or to each other is announced by The B. F. Goodrich Company, Akron, Ohio.

In using Plastilock 500 the company advises that best results are gained by applying heat with pressure, although heating alone will give some degree of adhesion. Purpose of the pressure is to obtain good surface contact. The bond strength varies with the materials being adhered.

The new adhesive, used for metal-to-metal bonding, has shown a shear strength of 3250 lb. per sq. in. Tension strengths of 4000 lb. per sq. in. have been reached. Tests made after the bonding of wood and plastic to aluminum, which presents extremely difficult problems of adhesion, have resulted in the wood and plastic being torn because the strength of the bond was greater than that of these materials.

The W-K-M THROUGH-CONDUIT PIPELINE VALVE



Features and Advantages of the W-K-M Pipeline Gate Valve

1. When valve is full open, through-conduit provides an unobstructed passage through valve. This eliminates damaging effect of churning or turbulence when valve is handling abrasive-laden fluids at high-pressures and velocities.

2. When valve is either open or closed, seats are entirely sealed off—pressure tight. This feature insures long-lived seats entirely protected against abrasion, cutting, rust or corrosion.

3. When valve is full open, gate is drawn into upper body where it is surrounded by a mass of hard grease which protects it against rust or corrosion.

4. Through-conduit eliminates accumulation of foreign matter in the body or gate-cavity of the valve. This insures positive and perfect seal-off when gate is closed.

5. Should gravel, trash, splinters or other foreign matter collect in through-conduit while valve is cracked, such foreign matter is carried down with and held in the conduit when gate is closed. Under no conditions can such foreign matter prevent positive closing of valve. When valve is again opened, foreign matter washes out of valve.

6. Double wedge construction of gate insures positive seal-off on both seats, in either open or closed position.

7. When valve is either open or closed, there is no pressure in the body or bonnet.

8. Freedom from pressure in body or bonnet while valve is in open or closed position permits replacing of packing while valve is in service and under pressure.

9. Freedom from pressure in body or bonnet while valve is in open or closed position permits removal of bonnet, stem and stem guide for replacement while valve is in service and under full-rated pressure.

10. To our knowledge this is the only lubricated gate valve made which uses the body of the valve as a lubricating housing for the working parts, insuring thorough and positive lubrication over a period of years without replenishing.

11. Freedom from internal corrosion because of constant lubrication by hard grease with which body is packed.

12. Great ease of operation under pressure, and freedom from excessive friction because of constant lubrication of working parts, and also because seat area is greater than area of gate exposed to pressure.

13. Parallel seats insure positive closure on both sides at any temperature.

14. Gates expand uniformly under high temperature, thus eliminating chance of galling or seizing.

15. Combination wipe-and-seal ring, which is kept constantly in contact with gate, keeps seats and gates free from deposits, cleaning at every operation of the valve.

16. Freedom from leaks around stem or bonnet due to lack of pressure against packing or gaskets when valve is open or closed.

17. Safety in case of fire, since there is no pressure in body of valve in either open or closed position. Stem packing could be entirely burned out without affecting tightness of valve in these positions.

18. Quadruple seal against leaks through stem or bonnet when valve is open or closed as compared to single seal on conventional types of valves.

19. Sextuple seal against leaks through valve as compared to single protection provided by conventional types of valves. The W-K-M Valve has three separate seats on each side, and seals off on all six seats in either the open or closed position.

20. Body serves as cooling chamber when valve is used on high temperature work and lubrication is not possible.

21. Renewable seats reduce maintenance cost to a minimum. Gates may be refaced five or six times before replacement becomes necessary.

22. Less radial clearance is necessary for installing screw end type.

23. In pipe line work, through-conduit permits cleaning of line with valve in place.

W-K-M Company, Inc.

OIL FIELD, PIPE-LINE & INDUSTRIAL EQUIPMENT

HOUSTON, Texas, U. S. A.

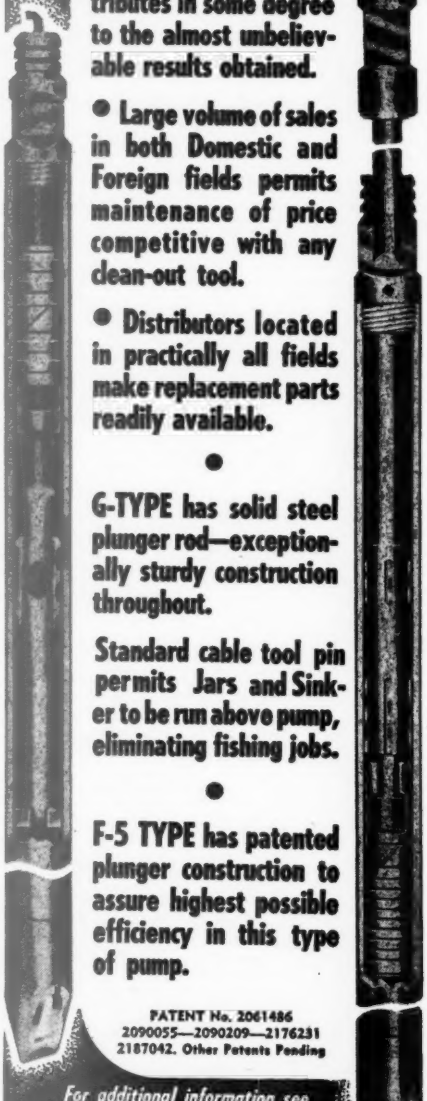
Export Office: 74 Trinity Place, New York

Cable Address: "WILKOMAC"

INCREASE PRODUCTION
MIDCO BAILER
CUT CLEAN OUT TIME IN HALF...

TYPE F-5

TYPE G



- Every individual feature of the MIDCO contributes in some degree to the almost unbelievable results obtained.
- Large volume of sales in both Domestic and Foreign fields permits maintenance of price competitive with any clean-out tool.
- Distributors located in practically all fields make replacement parts readily available.

●

G-TYPE has solid steel plunger rod—exceptionally sturdy construction throughout.

Standard cable tool pin permits Jars and Sinker to be run above pump, eliminating fishing jobs.

●

F-5 TYPE has patented plunger construction to assure highest possible efficiency in this type of pump.

PATENT No. 2061486
2090055—2090209—2176231
2187042. Other Patents Pending

For additional information see COMPOSITE CATALOG, Page 1903
Call, wire or write

MIDCO BAILER CO.
1006 - 1012 S. E. 29th STREET
TELEPHONE 7-8586 BOX 1542
OKLAHOMA CITY • OKLAHOMA

(8) *Air-actuated clutch*

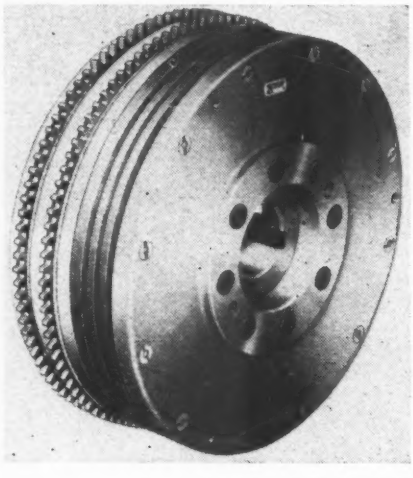
The Twin Disc Clutch Company, Racine, Wisconsin, manufacturers of industrial clutches and hydraulic drives, announces its new air-actuated clutch, for remote control set-ups and where "feather-touch" engagements in heavy-duty operations are necessary.

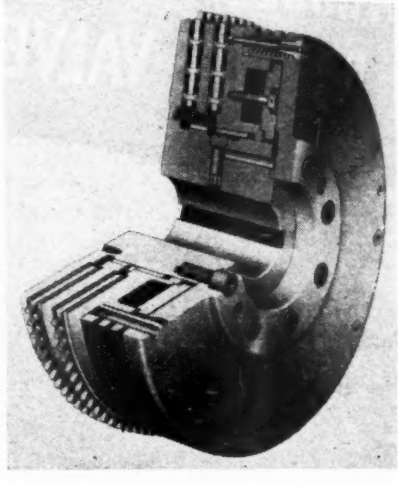
The new clutch is known as the Twin Disc Model P Air-Actuated Clutch. It retains many of the features of the familiar heavy-duty Twin Disc Model E (friction) Clutch and may be used in many of the same types of installations as the latter clutch, it is stated.

The Model P has a hub and back plate, center plate, floating plate, and friction disks of essentially the same proportions as the Model E, and is manufactured in a wide range of sizes, from 14 to 36 in., and capacities from 65 to 895 hp.

The air-actuated clutch operates by remote control without a complicated linkage system and shaft space is greatly reduced. It has ideal operating characteristics because any amount of air pressure, within limits, can be applied to the friction plates to provide either slow or fast engagement, the manufacturer states. Few moving parts are employed, which assures easy maintenance.

The Model P design provides two different methods for handling the actuating air supply, depending upon where the clutch is mounted: First, by drilling the shaft and using an end shaft rotary air seal; second, by using a special shaft-around, or mid-shaft rotary air seal.



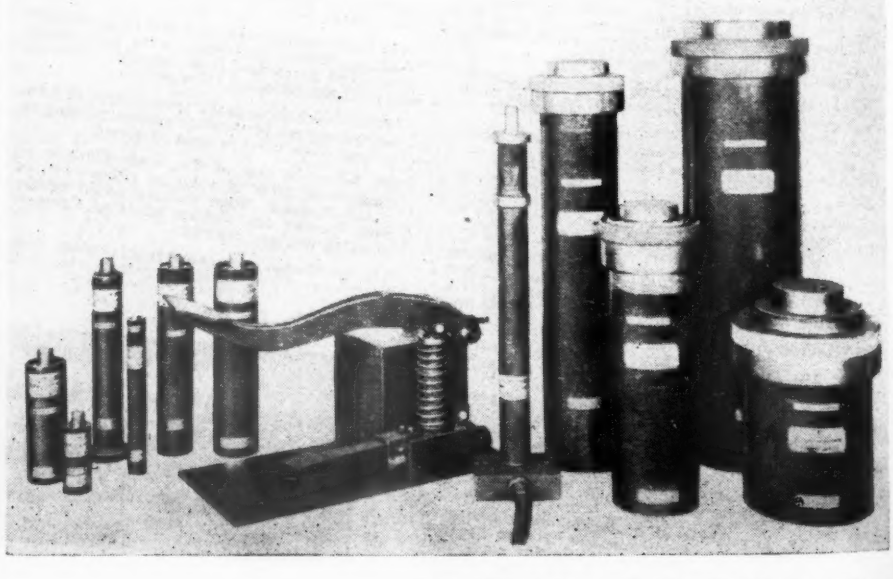


(9) *Hydraulic rams*

Typical of the all-steel aircraft style construction used throughout the general design of the Hy-Speed tools manufactured by Reimuller Brothers Company, of 9400 West Belmont Avenue, Franklin Park, Illinois, are the line of single acting rams illustrated.

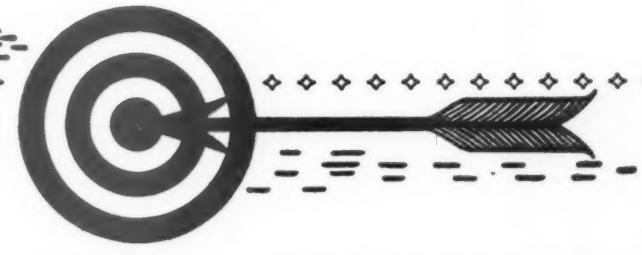
Using 4200 lb. per sq. in. as the basic pressure, a complete range of lightweight steel rams are available for assisting motivation or supplying force in many applications. Sizes available vary from ½ in. to 6 in. diam. They supply forces, if used with standard foot power units or motor driven pumps and valves manufactured by this company, of from 500 lb. to 40 tons.

These rams are easily and cheaply serviced and most of them can be supplied with spring return. When used with 1 cu. in. per stroke foot power units, movements of from 0.1 to 4 in. result.



ONE SOURCE FOR MORE THAN

4000 different kinds and sizes



Installing a piping system can mean time-consuming scouting and the fuss and bother of split-buying *unless* you go direct to the source for the most complete line of welding fittings and flanges—the Tube-Turn distributor. There is one in your locality.

His line of Tube-Turn welding fittings and flanges consists of *more than 4000 different kinds and sizes*—all of which are produced as a standard part of the line! He carries a comprehensive stock of these Tube-Turn items, and in most cases he will have exactly what you need for immediate delivery.

But the Tube-Turn distributor is more than a merchant. He is a pipe and fittings specialist who can give you a lot of bona fide, trouble-shooting engineering assistance. And—through the company's many branch offices and the famous Tube-Turn laboratory in Louisville the Tube-Turn distributor is backed for service by the nation's finest group of welding fitting engineers. They are the men who *originated* seamless welding fittings, and therefore have the most years of accumulated experience on tap for you.

Remember, Tube-Turn seamless welding fittings were the first. They are still the best.

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Selected Tube Turns Distributors in every principal city are ready to serve you from complete stocks.

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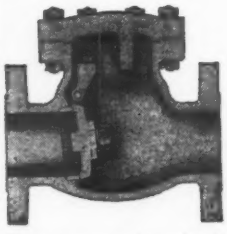
(10) *Swing check valves*

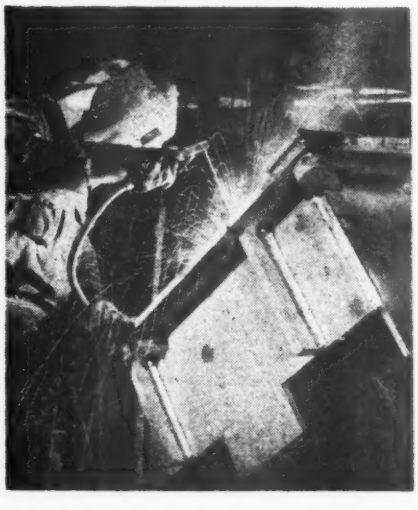


A new line of OIC cast-steel swing check valves in the 150 and 300-lb. pressure classes is announced by the Ohio Injector Company, Wadsworth, Ohio.

They are the full-way type in which the disk completely clears the waterway in the wide open position. The complete disk assembly is suspended from brackets inside the body and is removable as a unit through the cap opening.

(11) *GE electrode*

A new heavily covered arc-welding electrode for flat and horizontal fillet welding as well as for flat butt welding has been announced by the Electric Welding Division of the General Electric Company. Desirable wherever weld requirements include high mechanical properties, rigid X-ray examination, good profile, high deposition rate, and good surface appearance, the applications of this electrode include pressure vessels and pertinent connections, heavy machine bases, and structural parts such as column plates, columns, roof trusses, beans, and girders where the thickness



of the section permits, company officials announce.

Known as Type W-27, the new electrode is characterized by an exceptionally high melting rate, which results in increased production and higher speeds at the same welding current as other electrodes, it is asserted. At comparable production speeds, Type W-27 requires less heat input to the joint, thus reducing warpage and internal cooling stresses, according to the manufacturer.

Readily recognized by its steady, forceful, spray-type arc, the new electrode operates on alternating current or direct current with either straight or reverse polarity. It has low spatter loss and easy slag removal and produces welds of excellent appearance. It is available in three sizes: 3/16 by 18 in., ¼ by 18 in., and 5/16 by 18 in., and is rated A. W. S. classes E6020 and E6030.

(12) *Gathering pump unit*

Designed for gathering in the oil fields, a new Blackmer heavy duty pump incorporates a number of important changes and improvements, according to an announcement by E. W. Chapman, chief engineer of the Blackmer Pump Company, Grand Rapids, Michigan.

The specifications are as follows:

Capacity, 90 gal. per min.

Pressure to 500 lb. per sq. in.

Mechanical efficiency at 500 lb. per sq. in., 85 per cent.

Suction pressure, 0 to 100 lb. per sq. in.

Viscosities handled, 40 to 500 SSU—Specific Gravity 0.82.

Power, engine or motor.

The pump, reduction gearing, clutch and prime mover are mounted on a fabricated steel skid making a compact unit, which is easily moved in the field.

Chapman states that the pump is equipped with special anti-friction bearings and that the stuffingbox is so designed that vacuum is maintained on the packing chamber. The effect of the design is virtually to eliminate leakage, he says.

This unit is designed especially for the outdoor service, and is therefore of particularly rugged construction.

(13) *Burn treatment*

A new chemical formula, Hydrosulphosol Ointment, is being introduced to industry by the Davis Emergency Equipment Company, Newark, New Jersey, after 6 years of extensive clinical tests. The product is being hailed as the most advanced and successful treatment of painful burns yet discovered, according to the manufacturer.

Hydrosulphosol Ointment and Hydrosulphosol solution, the company's introductory publicity says, is the first burn treatment to have passed a thorough and intensive study over so long a period before being offered for industrial use. Both the ointment and the liquid solution have been used successfully in hospitals for the last 4 years on all types and degrees of burns.

Reports published in a number of America's leading medical journals, offering test cases and specific results, point up the powerful healing values of Hydrosulphosol Ointment through its chemical barrier to oxygen. Hydrosulphosol, the reports say, not only thwarts penetration by oxygen into scarred tissues, but by itself suffusing the damaged tissues, breaks down oxidized cells and helps stimulate the natural restoration of injured tissues.

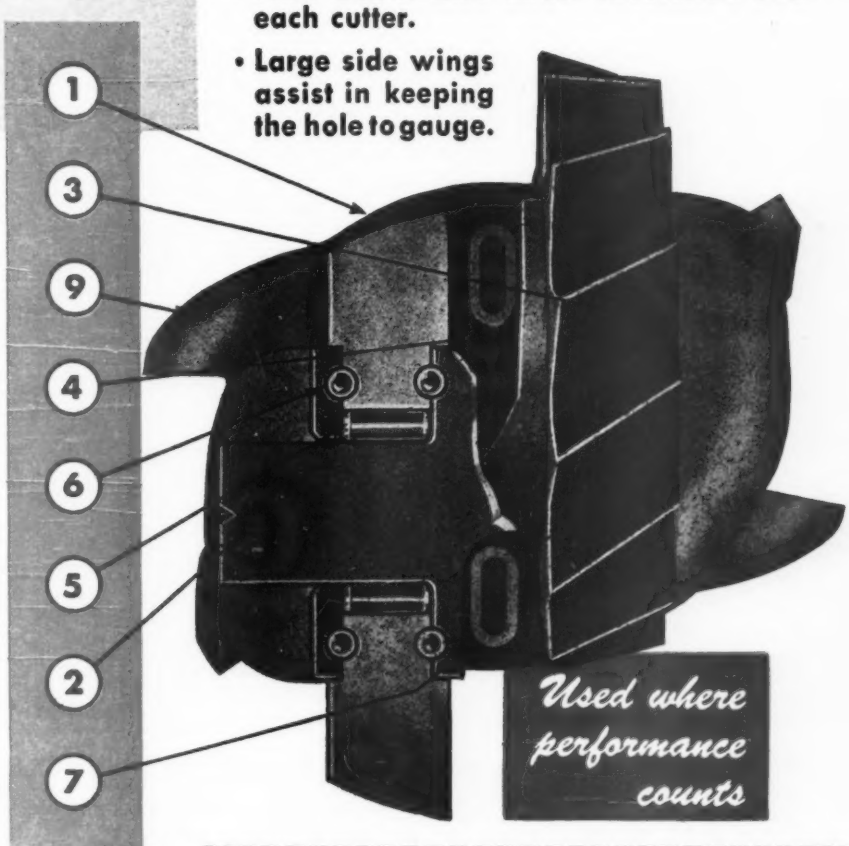
The Davis company introductory material on this new sulfhydryl solution lists its major healing features as: Quick relief from pain, infection control, acceleration of healing, non-toxic safety, and the stimulation of new tissues or repair of burned ones to check the danger of disability.

FOR FAST ECONOMICAL DRILLING

Grant ROLLER CUTTER SHALE BIT

Note the many advantages of the GRANT Roller Cutter Bit.

- **Extra large cutters, properly hard faced for long wear—this means faster more economical drilling.**
- **Flow beans extended to bottom of bit, allowing circulation to strike bottom of hole without interference.**
- **Flow beans also direct circulation over each cutter.**
- **Large side wings assist in keeping the hole to gauge.**



Used where performance counts

- **Smooth operation and more than adequate strength result from the use of roller bearings for radial load and ball bearings for thrust.**
- **Streamline design prevents excessive friction and balling up.**
- **No lost cutters due to ruggedness of trunnion and cutter assembly.**

(1) Shank. (3) Hardfaced Teeth. (9) Reaming Wings. (4) Washers. (6) Ball Bearings. (5) Roller Bearings. (2) Eccentric Trunnion. (7) Circulation Flow Beans.

Cutters are available for soft, sticky shale; medium Shale and hard Shale.

For complete information on the Shale Bit and other GRANT Products, check and mail the coupon below.

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☐ Safety Automatic Pressure Releases (Mud Pumps)

VERY NEAT---

But Also Highly Efficient

The men who build Layne Well Water Systems like to turn out a neat job of pump, motor and control installation. But it is the engineers in the factory who are responsible for their extra high over-all efficiency. First, they considered all of the well conditions—diameter, depth, static water level, capacity, drawdown and total head. Then the size and stages of the pumps, proper diameter and length of column pipe and line shaft and thus determined the right horsepower to deliver the required amount of water into the user's system.

These same engineers created the pump design, specified the kind and size of bearings and saw that all parts were precision built of the finest quality materials. The result is a highly efficient, complete water system that will pay extra dividends in long life, low operation cost and freedom from mechanical faults.

Layne installed wells and Layne vertical turbine pumps are fully recognized by the most eminent engineers as being the finest in quality and the most efficient ever built.

If you need more, either from additional wells, or from reconditioned old wells, write for further details. Address LAYNE & BOWLER, INC., General Offices Memphis 8, Tenn.

***LAYNE PUMPS** — fulfill every need for producing large quantities of water at low cost from wells, streams, mines or reservoirs. Send for literature.*

AFFILIATED COMPANIES: Layne-Arkansas Co., Stuttgart, Ark. ★ Layne-Atlantic Co., Norfolk, Va. ★ Layne-Central Co., Memphis, Tenn. ★ Layne-Northern Co., Mishawaka, Ind. ★ Layne-Louisiana Co., Lake Charles, La. ★ Louisiana Well Co., Monroe, La. ★ Layne-New York Co., New York City ★ Layne-Northwest Co., Milwaukee, Wis. ★ Layne-Ohio Co., Columbus, Ohio ★ Layne-Texas Co., Houston, Texas ★ Layne-Western Co., Kansas City, Mo. ★ Layne-Western Co. of Minnesota, Minneapolis, Minn. ★ International Water Supply Ltd., London, Ontario, Canada

LAYNE

WELL WATER SYSTEMS
VERTICAL TURBINE PUMPS

(14) *Orifice computer*

A new orifice computer is available in 2 sizes for office, field, or shop use. It is constructed primarily of cellulose acetate.

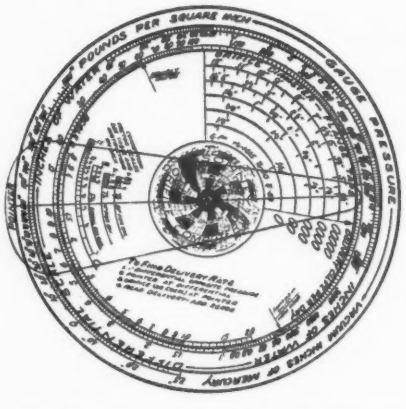
The equipment is designed to permit operators to make orifice meter computations quickly and easily, in any industry where gas, steam, and water are measured by the orifice principle.

The range of deliveries, pressures, differential, and sizes of orifice cover practically all conditions met in ordinary practice. A booklet of simple but complete directions for operating is provided with each computer.

This new device is particularly adaptable in determining:

1. Rate of flow of any gas in cubic feet per day or per hour;

2. Rate of flow of steam in pounds per day or per hour;



3. Rate of flow of water in any convenient units;

4. Size of orifice to install in a meter;

5. Differential or pressure to maintain to deliver a desired rate of gas, steam, or water;

6. Approximate coefficient for the orifice from known or assumed gas characteristics, and

7. Open flow rate when using the orifice open flow tester.

Although no coefficient for the orifice is necessary for ordinary computations, correction factor scales and table of standard coefficient settings for both flange and pipe taps are provided for use where more accurate computation is desired.

The equipment is available in utility size, 4¾ in. diam., suitable for field and shop use, and larger desk size of 7½ in. diam.

The manufacturer is Willsonn Computers, 925 Central Avenue Ext., Oil City, Pennsylvania.

---

(15) *Spectrophotometer*

The new Beckman Model 1R-2 infrared spectrophotometer embodies many important advancements in accuracy, adaptability and simplicity of operation, according to the manufacturer, National Technical Laboratories, South Pasadena 26, California.

Earlier instruments were designed specifically for routine analysis of hydrocarbons. The new Model 1R-2, while it is suitable for routine analysis of gases, liquids or solids, has the following useful features:

Unusual versatility is provided by interchangeable elements. Various types of light sources, cell holders, etc., can be interchanged to adapt the instrument to a wide range of applications on liquids, solids and gases. Even cells with path-length of a meter or more can be used.

Increased accuracy and stability are obtained through use of a new energy measuring system employing a bolometer and vacuum tube amplifier. This system eliminates temperature drift, non-linearity errors, and vibration difficulties.

Constant temperature insures accuracy at all wavelengths. The monochromator and cell compartments are thermostated, eliminating the uncertainty of inadequate "temperature compensation" and making a constant-temperature room unnecessary.

Quick easy readings can be made directly in per cent transmission and optical density, and provisions are made for direct-connecting a standard potentiometer-type recorder. The wavelength range is 1 to 15 microns and wavelengths can be selected either by a continuous wavelength drive calibrated directly in microns or by a 17-position stop-mechanism that greatly simplifies routine analysis operations. Accessory equipment includes a motor drive for continuous wavelength scanning.

Constant radiation at all times is another important advancement. The source of radiation is a photo electronically stabilized Nernst lamp that insures constant radiation regardless of line voltage fluctuations.

Hermetically sealed, the optical path is free of CO_2 and water vapor. Two-stage drying protects precision optical elements.

---

(16) *Wiggins coupling*

The E. B. Wiggins Oil Tool Company, Inc., Los Angeles, California, announces development of a new direct-connect coupling, specially adapted for use in testing operations.

The new coupling fits over the end of any standard type AND 10056 nipple, the "dogs" of the coupling gripping securely in the undercut just behind the threads of the nipple. Connecting any fluid or air line with the Wiggins direct-connect coupling takes only a second and users report saving up to 80 per cent in time and labor, the manufacturer states.

The coupling has application in the manufacture of carburetors, aircraft, automobile, refrigeration, air conditioning equipment, metering gages, valve gages, and hydraulic equipment. The coupling is made of durable light-weight aluminum. It fits all standard type AN nipples with the undercut and since these are available with or without the undercut, the former can be installed when reordering nipples. Wiggins direct-connect coupling comes in sizes of ¼, 5/16, ⅜, ½, ⅝ and ¾ in.

HERE IS AN UNPARALLELED ACHIEVEMENT IN COMPLETION

Control

The Cameron Ram Type Tubing Control Head

Employing numerous features of the famous Cameron Drilling Control Units, the Ram-Type Tubing Control Head provides positive blowout protection while tubing is being run, well washed, packer collapsed, tubing suspended, etc. As the foundation for the Cameron Closed Pressure Method of Well Completion, this tubing head has demonstrated its incomparable safety and efficiency on hundreds of the world's deepest, highest pressure wells. Its unique design, providing ram-type blowout preventer control during initial completion or re-completion operations and permitting the use of several types of tubing suspension and seal, makes it equally outstanding in the field of equipment required for multi-zone completions.

The most widely used type of suspension and seal—the hanger nipple equipped with back-pressure valve and suspended and sealed on the closed rams of the head—is illustrated in the cross-section view above.

CAMERON IRON WORKS, INC.

711 MILBY STREET • HOUSTON, TEXAS

Export: 74 Trinity Place, New York, N. Y. • *California:* Howard Supply Co., Los Angeles • *Rocky Mountain:* Mountain Sales & Service, Casper, Wyoming *Oklahoma:* 310 Thompson Building, Tulsa

★ ★

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"The Entirely Different Boiler and Engine Treatment"

The men in direct charge of boiler maintenance prefer Sand-Banum because it comes ready to use.

Is easy and simple to handle—harmless to personnel and equipment.

Is applied only once a week; unaffected by age, climate, water or operating conditions.

Management prefers Sand-Banum because it keeps boilers clean, resulting in increased operating efficiency, fewer shutdowns, longer equipment life, and fuel economy.

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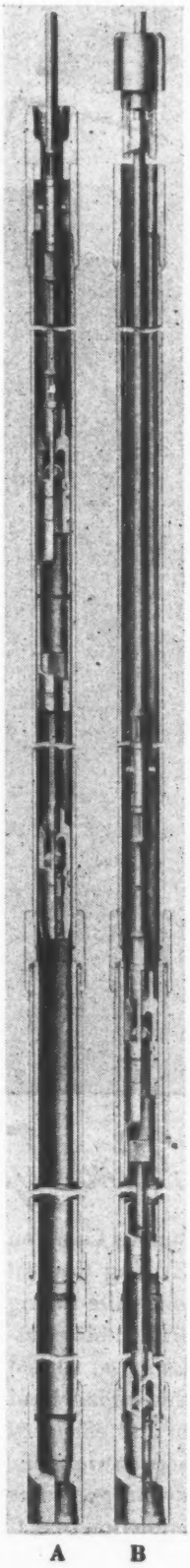
★ ★

(17) *Pump accessory*

The D+B Division of Emsco Derrick and Equipment Company has developed a new accessory for use on D+B oil well tubing liner pumps, known as a plunger hanger.

At the request of the United States Navy at the Elk Hills fields, D+B began engineering research and designing some months ago to develop a method whereby a larger size tubing liner pump could be operated on a smaller size string of tubing

The plunger hanger is an inexpensive devise composed of three parts: A top half with a sleeve at its lower end, which connects to the small tubing, a bottom half that connects to the upper half giving support to the sleeve, and a special sucker rod coupling with a pin protruding through the sides. The top half is threaded to make up on the tubing string used in the well. The bottom half is threaded to take the top half of the hanger and its lower end is threaded to connect to one joint of tubing of corresponding size to the tubing pump used. The sleeve on the lower end of the top half into which the bottom half is threaded is machined with two inverted "J" slots to take the special sucker rod coupling. To install the plunger hanger one joint of tubing must be used of the same size as that of the pump to be used. For example, if a 3-in. tubing liner pump is to be run on a string of 2½-in. upset tubing, one joint of 3-in. upset range 3 tubing is made up in the top end of the pump. On the other end of this joint of tubing the plunger hanger is installed. From the plunger cage of the pump the assembly consists of a short pony rod, the special coupling with the pin protruding through the sides and one standard length of sucker rod.



A B

At the time the pump is being lowered into the well the plunger is suspended in the joint of large tubing with the protruding pins on the sucker rod coupling located in the "J" slot. After the tubing is lowered in the well, the sucker rods are lowered and screwed on the rods already in the well. In order to start pumping it is necessary to raise the sucker rods slightly so the protruding pins of the sucker rod coupling clear the lips of the "J" slot, turn to the left a quarter turn, and then lower the plunger to the pumping position. The standing valve can be released and the pump is ready to start operation.

In pulling the pump, the plunger is lowered to pick up the standing valve in the conventional manner. Then the plunger and standing valve are raised by means of the sucker rods to completely remove the plunger and standing valve from the liner column into the upper joint of tubing. As this is done the protruding steel pins on the sucker rod coupling are guided into the "J" slot, the rods are turned a quarter to the right, and lowered to rest in the slot provided. In this position the plunger and standing valve are hung in the joint of tubing above the pump, allowing the oil to drain around the special sucker rod coupling, plunger, and standing valve. The "J" slot then acts as a clutch in breaking the sucker rod string. After the sucker rods have been removed from the tubing, the tubing can be removed from the well. The fluid will drain through the pump permitting the tubing column to empty the oil contained in it as it is pulled. Thus the operator can pull his tubing string "dry" instead of "wet" as he has had to do in the past.

In the photograph A shows the plunger hanger made up with a tubing liner pump, with the plunger and standing valve removed from the liner column and suspended in the joint of large tubing immediately above. The protruding pins on the special sucker rod coupling are in the "J" slot in the lower end of the top half of the hanger. This position of the plunger and standing valve permits the oil to drain around the special sucker rod coupling, plunger, and standing valve. B displays the position of the plunger hanger while the pump is in operation. For purposes of illustration, the top half of the plunger hanger is shown separated from the lower half. Note that the standing valve has been released and the plunger is in normal pumping position.

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(18) *Multiple cylinder pumps*

Employing the principle of multiple cylinders, and mounting within the cylinders double-acting pistons operated from a single crankshaft, Frank Wheatley, Sr. of Tulsa, Oklahoma, a few years ago built a pump capable of handling enormous volumes of fluid at high speeds with little or no surge. United States Patent No. 2,367,452 has been granted

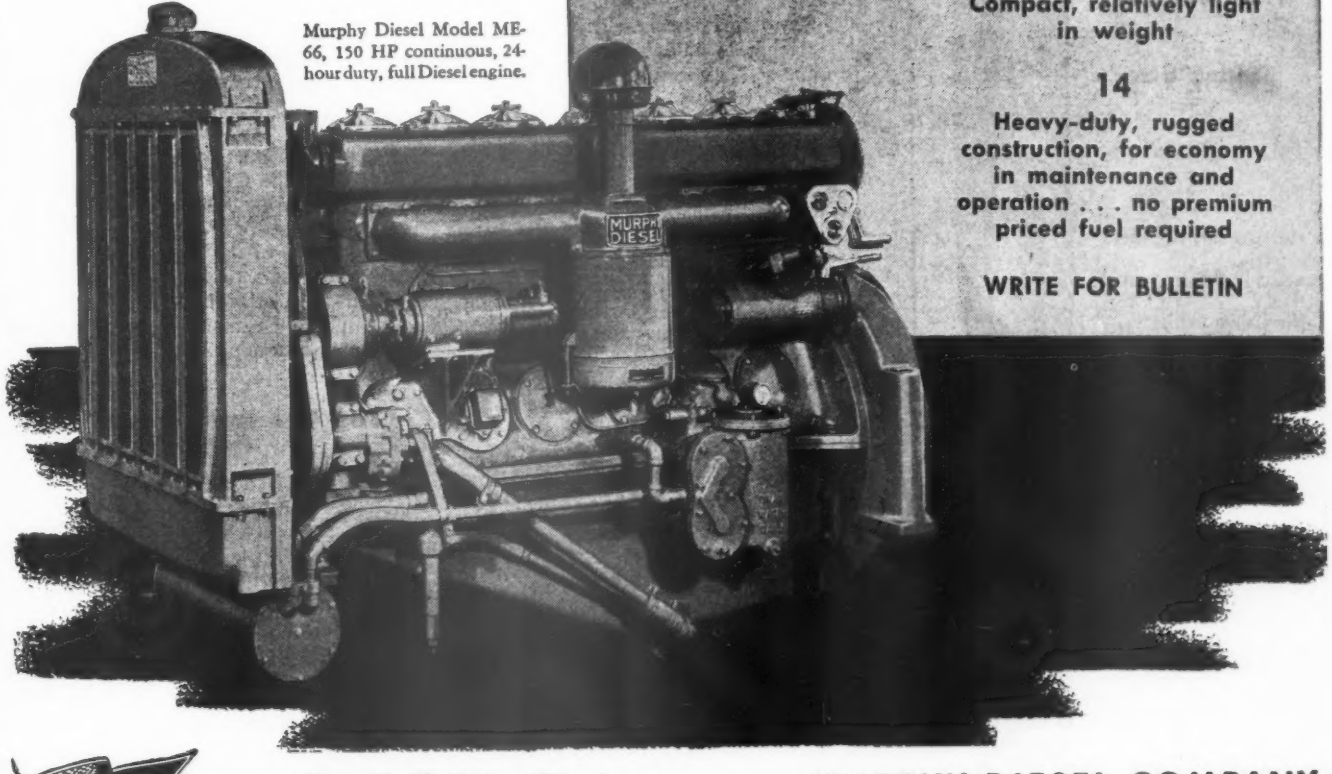
Proven IN THE FIELD!

MURPHY DIESELS are made as engines, power units, enclosed power units . . . equipped, as specified, with clutches or outboard bearings, and available with either radiator or heat exchanger cooling. All are engineered to highest efficiency standards, to assure more power, more profit to users . . . as evidenced by these outstanding features:

MURPHY DIESEL *Outstanding Features:*

1. MURPHY UNIT INJECTOR
2. 24-volt electric starting
3. Ample filters for lubricating and fuel oils
4. Plain open combustion chamber
5. Copper-lead-alloy, steel-backed, precision bearing shells
6. Through steel tie-bolts
7. Tocco hardened crankshaft
8. Hydraulic Servo-type governor
9. Safety control
10. Oil cooler
11. Oil cooled pistons
12. Four valves per cylinder
13. Compact, relatively light in weight
14. Heavy-duty, rugged construction, for economy in maintenance and operation . . . no premium priced fuel required

WRITE FOR BULLETIN



Murphy Diesel Model ME-66, 150 HP continuous, 24-hour duty, full Diesel engine.

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More Profit

Engines: FROM 90 to 215 HP

Generators: FROM 60 to 115 KW

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Count on

DEPENDABLE PERFORMANCE

with the

ROBINSON

HOOK WALL PACKER

Tubing Size

This high quality Robinson Packer is run on tubing, and used in flowing and pumping wells . . . and can be used to pack off water in leaky casings. Other high standard features—

- Case hardened steel slips.
- Rods may be installed after well ceases to flow, and packer may be used as pumping packer.
- May be raised or lowered and reset.

ROBINSON PACKER CO.

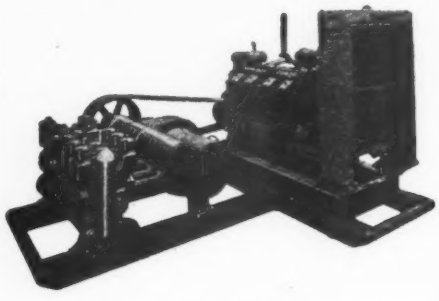
P. O. Box 1408

TULSA, OKLAHOMA

Factory: Coffeyville, Kansas

covering the multiple cylinder pumps as of January 16, 1945, according to official notice received by Frank Wheatley Pump and Valve Manufacturers.

The Wheatley multiple cylinder pumps have been widely accepted, particularly in the pipe line industry where the plurality of pistons from the same crankshaft imparts a sufficient number of im-



pulses to the fluid during each revolution of the crankshaft virtually to eliminate surge.

Another unusual feature of the Wheatley multiple cylinder pumps is that the cylinders are so arranged that, if desired, two different fluids can be pumped at different volumes and under different pressures. The pumps are made in 3 and 5 cylinder models.

(19) *Liner cleaner*

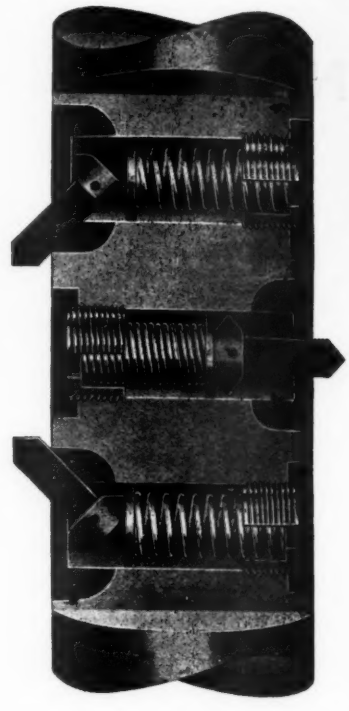
A liner cleaner comprising a mechanical device for cleaning vertically slotted liners has been announced by B. & B. Tool Company of Bakersfield, California. Twenty spring-steel blades are spirally spaced at ¾-in. offsets around the body of the tool and are in contact with heavy coil springs that exert great thrusting pressure against the blade cam. The blades are free to move up and down and can retract directly into the body of the tool. The cleaner is lowered to the bottom of the liner either on a sand line, tubing or drill pipe and then moved progressively upward in short, slow, up-and-down strokes. As the blades come in contact with the slots in the liner they are driven out through the slots penetrating beyond the outside diameter of the liner to the following dimensions:

4¾-5 -in. liners opened up to 6¾ in.
5½-5¾-in. liners opened up to 7½ in.
6⅝-7 -in. liners opened up to 9½ in.
8⅝-9 -in. liners opened up to 10½ in.

The spirally spaced blades, together with the line twist when run on a wire cable, keep the tool gradually creeping in a rotational movement. This is important, and it is asserted that more than 90 per cent of all the perforations can be opened by this mechanical cleaning tool.

General practice is to reclean the liner several times for good measure. A bailer is run to keep the well clean to bottom, followed up with a double bypass vacuum sand line washer to pull in all loosened material from around the liner.

In addition to removing sand, mud, water scales, and corrosive material from the liner perforations, effective results have been obtained in cleaning gravel packs with this liner cleaner. It has been used successfully in reopening perforations after squeeze cementing in multiple-zone completions. Frequently in squeeze cementing to isolate producing



zones some cement will migrate along the outside of the pipe and into the perforations opposite these zones. After the bridge plug or baffle plate and any cement left in the pipe are drilled out, the tool is run to gouge out the cement left in the perforations and to penetrate through any cement sheath around the outside of the pipe.

(20) *Leadmetal compound*

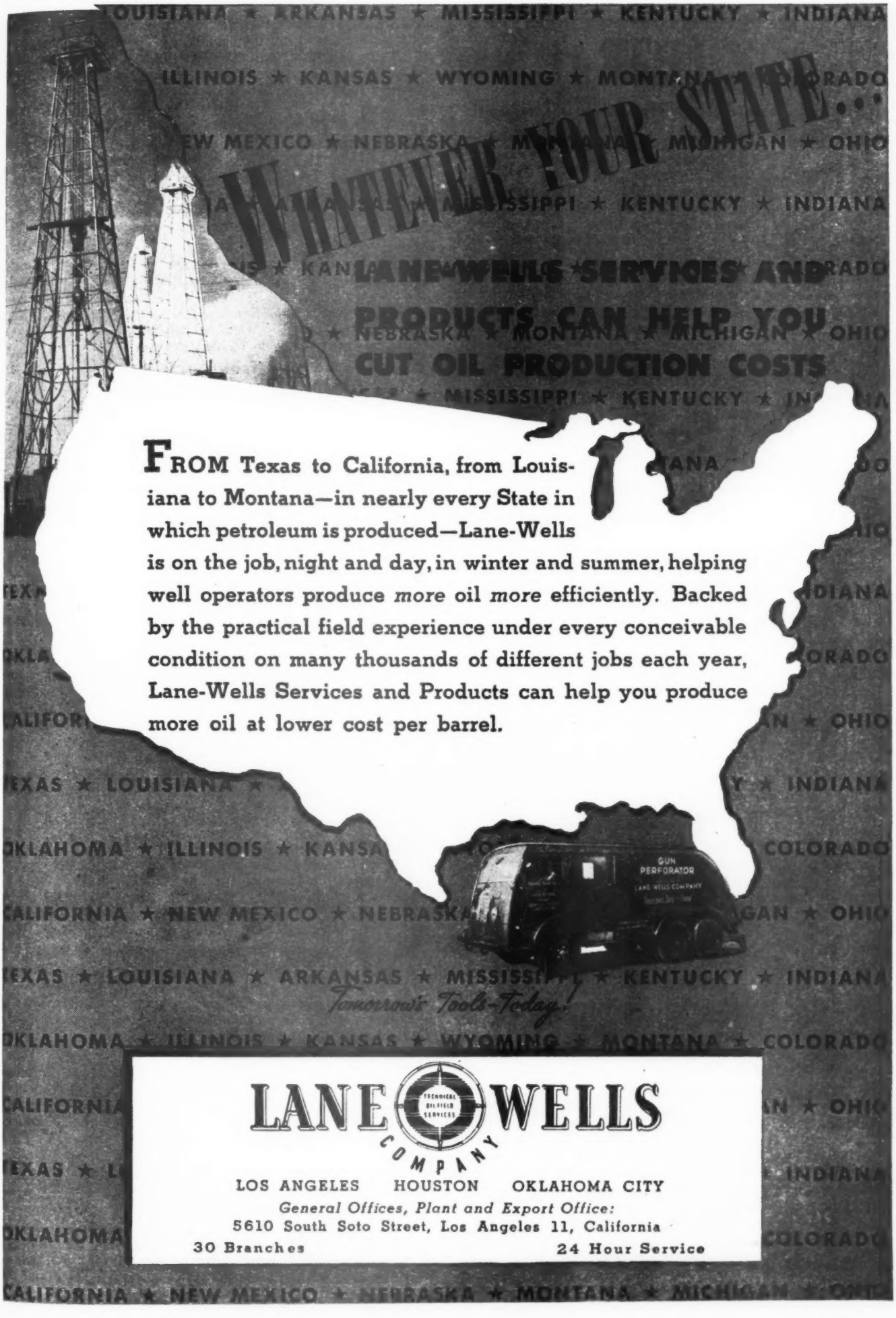
Norm, a leadmetal thread and gasket compound, is now being offered to the petroleum industry. Designated as Norm No. 30 Leadmetal this compound which, the manufacturer states, withstands vibration, corrosion, and galling under extreme pressures and temperatures is used on studs and bolts, as a packing lubricant for lathe centers, pipe threads, engine splines, threading and tapping, and wire line.

Having heavy molecular weight, it withstands pressures and vibration. Its lead content insures against corrosion, galling and seizing. There being no affinity for other metals, the joint will separate freely upon dismantling.

A correct lubricant for engine splines, it prevents galling and pick-up.

Used on wire line, it prevents corrosion while acting as a lubricant.

When used on studs, bolts, turnbuckles and running threads, Norm No. 30 prevents failures such as seizing and twisting off cylinder head studs. Its weight and malleability, when applied to packing greatly improves its performance, stopping stuffingbox blowing and leakage. Norm No. 30 Leadmetal is manufactured by Specialty Sales Company, 2344 Orange Avenue, Long Beach, 6, California.


LOUISIANA ★ ARKANSAS ★ MISSISSIPPI ★ KENTUCKY ★ INDIANA
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FROM Texas to California, from Louisiana to Montana—in nearly every State in which petroleum is produced—Lane-Wells is on the job, night and day, in winter and summer, helping well operators produce more oil more efficiently. Backed by the practical field experience under every conceivable condition on many thousands of different jobs each year, Lane-Wells Services and Products can help you produce more oil at lower cost per barrel.
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TRADE LITERATURE

Publications listed are sent free upon request.

(21) *Precision safety heaters*

Precision Scientific Company, Chicago, Illinois, gives some interesting data on its new line of safety heaters in Bulletin HP-1650. A time-temperature curve for heating crude oil is presented in a chart and specifications for the heaters are shown in a table.

(22) *High-pressure boilers*

Feedwater treatment for high pressure boilers at Dow Chemical Company is described in a new bulletin, No. 1400, published by the Cochrane Corporation, Philadelphia, Pennsylvania. This article will be of particular use to engineers interested in the treatment of feed water for boilers of high pressure.

(23) *Ball reciprocating bearings*

High capacity ball reciprocating bearings, published by the Torrington Company, covers the latest listing of size and quantities of bearings. Application recommendations will be sent upon receipt of cross-section prints or sketch reference of housing and surrounding details.

(24) *Gas welding and cutting*

The 1945 Victor gas welding and cutting apparatus catalog, Form 23, one of the most comprehensive issued in the industry, is now available. A 104-page color publication, it reviews 3 decades of Victor products and illustrates all equipment and parts now available.

(25) *Grant oil tools*

Inormation on Grant oil tools from the company at Los Angeles, California, is now ready for distribution. Bailers, cleaners, hole enlargers, liner pullers, reamers, shale bits, underreamers, wall scrapers, and safety automatic pressure releases (mud pumps) are all listed and discussed in the new bulletins.

(26) *Catalog on valves*

Non-return valves, catalog 12-B; gate valves, catalog 12-E, and blow-off valves, catalog 12-D are all available from the Edward Steel Valve Company, East Chicago, Indiana. These catalogs list full dimensions, illustrations, and descriptions of the valves.

(27) *Data on valves*

Darling Valve and Manufacturing Company, Williamsport, Pennsylvania, has issued a catalog giving full information on its products. Included is complete information on the Darling line, together with illustrations and examples.

(28) *Steam tank heater*

Bulletin No. 451, issued by The Brown Fintube Company, Elyria, Ohio, describes the new steam tank heater that speeds the unloading of materials whose viscosity can be lowered by heating. It gives dimensions and weights of heaters for use with tank cars and trucks.

(29) *Classified directory*

The Association of Consulting Chemists and Chemical Engineers, Inc., New York, has issued its 9th edition of the Classified Directory listing the names of consultants specializing in any given field. This new catalog, issued earlier than usual due to many requests, contains 108 pages of information and guidance.

(30) *Metal parts washing*

The Optimus Equipment Company, Matawan, New Jersey, manufacturers of washing, rinsing, pickling, and drying equipment for metal parts, has issued Bulletin 4E2, describing portable machines of the dip-agitating type and the spray type. "Batch Cleaning in Portable Metal Washing Machines for Production Maintenance and Repair," is the name of the booklet.

(31) *Alco equipment*

The American Locomotive Company, Alco Products Division, has issued two booklets describing springs and triple service products. They are Bulletin 1034, describing the triple service products and Bulletin 5001, describing various types of springs designed and manufactured by the railway steel-spring division.

(32) *Shift couplings*

A new 8-page illustrated booklet, No. 2045, on a complete line of shaft couplings is announced by the Link-Belt Company. Sizes, dimensions, and list prices are given for couplings of flexible, rigid flanged face and compression types, with special emphasis on the type "RC" roller chain coupling. Detailed information is also given on protective casings for the "RC" coupling.

(33) *Steels*

Carbon and high speed steel drill rods and cold drawn tool steels are described in a new catalog of Allegheny Ludlum Steel Corporation, Brackenridge, Pennsylvania. Steels are furnished in 3 standard and 5 special grades. Information is given on lengths, sizes and weights, finishes, tolerances, and hardness value.

(34) *Liquid level control*

The Moore Products Company, Philadelphia, has issued an illustrated bulletin, No. 251-S on liquid level control. It includes instructions for installation, operation, and maintenance, and has a complete parts list. Detailed instructions for special applications are attached to the inside front cover.

(35) *Rod and piston packings*

Catalog No. 440 issued by the C. Lee Cook Manufacturing Company, Inc., Louisville, Kentucky, on rod and piston packings, is off the press. The book contains general descriptions, temperatures, pressures, rod materials, and a number of tables giving engineering data.

(36) *Steam jet ejectors*

Ingersoll-Rand Company announces the publication of a new bulletin covering steam-jet ejectors, of interest to all industries having need for vacuum-producing equipment. Some uses outside these fields are: Evacuating tanks for treating timber, vacuum packing, deaerating of soap, clay, etc., and producing simulated altitude conditions for testing engines, super-chargers, pumps, instruments, etc. Operating characteristics, principles, and features are given. Construction details and schematic diagrams of various single and multi-stage set-ups are included.

(37) *Award system*

An illustrated 40-page handbook covering in detail all phases of the new Cooper-Bessemer Corporation award system, are available for distribution. This is The Suggestion Plan, based primarily on the payment to employes of awards aggregating 10 per cent of the net savings resulting from suggestions, or 5 per cent of the gross savings for ideas submitted to cut operating costs. The award plan also provides payment for intangible ideas suggested and these awards are determined by an appraisal board. The booklet is available for distribution to industrial concerns planning the inauguration of either a Suggested Award Plan or a program of preparation for new employes.

(38) *Plastic coating*

Now available from the Amercoat Division of American Pipe and Construction Company of Los Angeles, makers and distributors of Amercoat plastic coatings, is a 4-page technical folder in 2 colors on their No. 44 Plastic Coating. Full details of uses and technical facts are covered in this new bulletin.

(39) *Storage and mixing equipment*

Bulletin 405 on storage and mixing equipment for acids and corrosive materials, is available from the U. S. Stoneware Company, Akron, Ohio. The publication includes a section on the installation and use of stoneware vessels, together with charts giving dimensions and specifications.

(40) *Oil refining*

Oil refining is the subject of an illustrated brochure issued by the M. W. Kellogg Company, New York City. The brochure covers such subjects as fluid catalytic cracking, alkylation and isomerization, hydroforming, polymerization, thermal cracking, suspensoid cracking, delayed coking, topping, deasphalting and desalting, vacuum distillation, naphtha reforming and reversion, gas recovery, storage systems, lube oil refining, etc. It is illustrated with flow sheets and installation photographs.

(41) *Weldors guide*

The latest edition of the "Weldors Guide" has been issued by the Mir-O-Col Alloy Company. The booklet includes an introduction in which it describes hard facing and tells what makes it useful. It is a 31-page pocket-style booklet, indexed and including complete information on hard facing welding.

THE *Petroleum* Engineer's CONTINUOUS TABLES

A DAILY REFERENCE FOR OPERATING MEN

INSTALLMENT NO. 93

A VALUABLE and regular feature of *The Petroleum Engineer*, the Continuous Tables, now in their seventh year of publication, were designed to save time and effort for the technician and the practical field or plant worker. The tables have proved one of the most popular and helpful departments of *The Petroleum Engineer*. Data are presented in the simplest form available with many types of information included that are best presented by curves or nomographs when three or more variables must be considered simultaneously.

The Continuous Tables have developed as a result of suggestions for new tables, direct contributions, and improvements to existing tables by members of the petroleum and related industries, including manufacturing concerns, who are continually searching for practical information reduced by computation to tabular form readily applicable to the problems daily confronting them that might otherwise necessitate a more or less tedious calculation. These contributions and suggestions from the industry have resulted in a valuable exchange of information and data contributing to the progress of the industry as a whole.

This index will be revised monthly. The index for installments 1-12, inclusive, will be found in the May, 1938, issue; 13-24, inclusive, in the June, 1939, issue; 25-36, inclusive, in the June, 1940, issue; 37-48, inclusive, in the June, 1941, issue; 48-60, inclusive, in the June, 1942, issue; 61-72, inclusive, in the June, 1943, issue; 73-79, inclusive, in the January, 1944, issue; 80-82, inclusive, in the April, 1944, issue; 83-85, inclusive, in the July, 1944, issue; 86-88, inclusive, in the October, 1944, issue, and 89-91, inclusive, in the January, 1945, issue.

INDEX TO TABLES

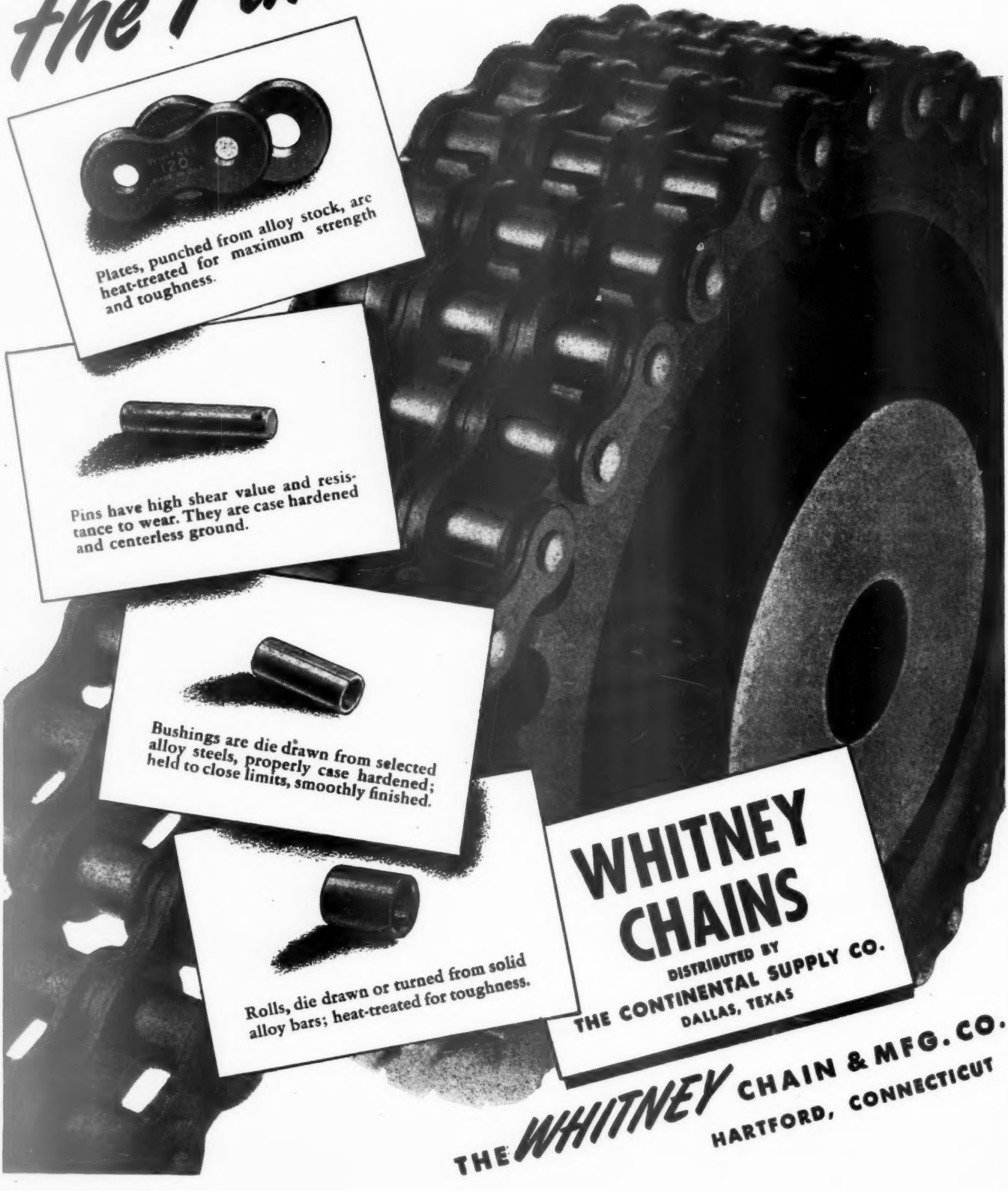
		Index No.	*Page*	*Issue*
Straight screw threads for high-temperature bolting	(sheet 1)	P 094.151	269	Mar.
Straight screw threads for high-temperature bolting	(sheet 2)	P 094.151	281	Mar.
Viscosity index chart		P 216.13	275	Mar.
Estimation of viscosity index		P 216.13	223	Feb.
Curves for estimating pressure drop in high pressure gas pipe lines		P 622.100.1	277	Mar.
Tank capacity chart		P 671.	221	Feb.
Pressure extensions—orifice meter calculations	(sheet 21-D)	P 683.32	227	Feb.
Pressure extensions—orifice meter calculations	(sheet 21-E)	P 683.32	229	Feb.
Pressure extensions—orifice meter calculations	(sheet 21-F)	P 683.32	231	Feb.
Pressure extensions—orifice meter calculations	(sheet 21-G)	P 683.32	233	Feb.
24-hour capacity of orifice meters—flange connections	(sheet 1)	P 683.320.11	271	Mar.
24-hour capacity of orifice meters—flange connections	(sheet 2)	P 683.320.11	273	Mar.
Positive meter factors—physical test car		P 686.510.1	225	Feb.
Charcoal testing meter factors for G.P.M.		P 686.511.0	279	Mar.

INDEX TO ADVERTISERS IN TABLES

		Page	*Issue*	*Backing Table No.*
Griscom-Russell Co.	(sheet 1)	270	Mar.	P 094.151.
Hazard Wire Rope Division of American Chain & Cable Co., Inc.	(sheet 2)	274	Mar.	P 683.320.11
Hyatt Bearings Division, General Motors Corp.	(sheet 2)	272	Mar.	P 683.320.11
Maxim Silencer Co.		278	Mar.	P 622.100.1
Nash Engineering Co.	(sheet 2)	282	Mar.	P 094.151.
Torrington Co., Bantam Bearings Division		280	Mar.	P 686.511.0
Visco Products Company, Inc.		276	Mar.	P 216.13

The Proof is in the Parts

Whitney Roller Chains are built to give positive, powerful performance in the constant service demanded by wartime schedules. Every part may be relied upon to do its part.



Plates, punched from alloy stock, are heat-treated for maximum strength and toughness.

Pins have high shear value and resistance to wear. They are case hardened and centerless ground.

Bushings are die drawn from selected alloy steels, properly case hardened; held to close limits, smoothly finished.

Rolls, die drawn or turned from solid alloy bars; heat-treated for toughness.

WHITNEY CHAINS

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THE CONTINENTAL SUPPLY CO.
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STRAIGHT SCREW THREADS FOR HIGH-TEMPERATURE BOLTING

Limiting Dimensions and Tolerances for Threads on Screws

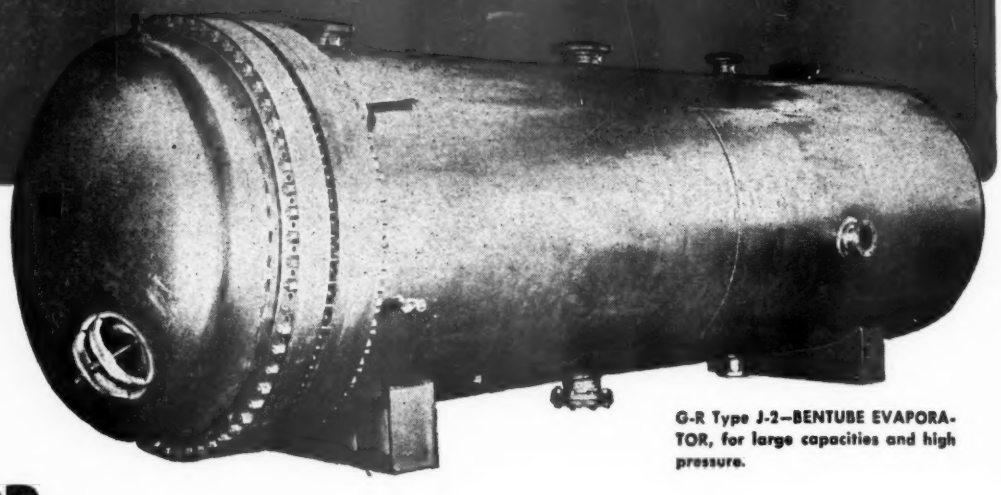
Sizes	Threads per inch	Basic major diameter	Allowance (minus)[2]	Major diameter			Pitch diameter			Minor diameter, max.
				Max.	Min.	Tolerance	Max.	Min.	Tolerance[1]	
A	B	C	D	E	F	G	H	I	K	L
¼	20	0.2500	0.0010	0.2490	0.2418	0.0072	0.2165	0.2139	0.0026	0.1877
5/16	18	0.3125	0.0011	0.3114	0.3032	0.0082	0.2753	0.2723	0.0030	0.2432
⅜	16	0.3750	0.0013	0.3737	0.3647	0.0090	0.3331	0.3299	0.0032	0.2970
7/16	14	0.4375	0.0013	0.4362	0.4264	0.0098	0.3898	0.3862	0.0036	0.3486
½	13	0.5000	0.0015	0.4985	0.4881	0.0104	0.4485	0.4448	0.0037	0.4041
9/16	12	0.5625	0.0016	0.5609	0.5497	0.0112	0.5068	0.5028	0.0040	0.4587
⅝	11	0.6250	0.0017	0.6233	0.6115	0.0118	0.5643	0.5601	0.0042	0.5118
¾	10	0.7500	0.0019	0.7481	0.7353	0.0128	0.6831	0.6786	0.0045	0.6254
⅞	9	0.8750	0.0021	0.8729	0.8589	0.0140	0.8007	0.7958	0.0049	0.7366
1	8	1.0000	0.0022	0.9978	0.9826	0.0152	0.9166	0.9112	0.0054	0.8444
1⅛	8	1.1250	0.0024	1.1226	1.1074	0.0152	1.0414	1.0359	0.0055	0.9692
1¼	8	1.2500	0.0025	1.2475	1.2323	0.0152	1.1663	1.1605	0.0058	1.0941
1⅜	8	1.3750	0.0025	1.3725	1.3573	0.0152	1.2913	1.2852	0.0061	1.2191
1½	8	1.5000	0.0027	1.4973	1.4821	0.0152	1.4161	1.4098	0.0063	1.3439
1⅝	8	1.6250	0.0028	1.6222	1.6070	0.0152	1.5410	1.5345	0.0065	1.4688
1¾	8	1.7500	0.0029	1.7471	1.7319	0.0152	1.6659	1.6591	0.0068	1.5937
1⅞	8	1.8750	0.0030	1.8720	1.8568	0.0152	1.7908	1.7838	0.0070	1.7186
2	8	2.0000	0.0031	1.9969	1.9817	0.0152	1.9157	1.9084	0.0073	1.8435
2⅛	8	2.1250	0.0032	2.1218	2.1066	0.0152	2.0406	2.0331	0.0075	1.9684
2¼	8	2.2500	0.0033	2.2467	2.2315	0.0152	2.1655	2.1578	0.0077	2.0933
2½	8	2.5000	0.0035	2.4965	2.4813	0.0152	2.4153	2.4071	0.0082	2.3431
2¾	8	2.7500	0.0037	2.7463	2.7311	0.0152	2.6651	2.6564	0.0087	2.5929
3	8	3.0000	0.0038	2.9962	2.9810	0.0152	2.9150	2.9058	0.0092	2.8428
3¼	8	3.2500	0.0039	3.2461	3.2309	0.0152	3.1649	3.1556	0.0093	3.0927
3½	8	3.5000	0.0040	3.4960	3.4808	0.0152	3.4148	3.4055	0.0093	3.3426

For use with pressure vessels and steel pipe flanges, fittings and valves.
All dimensions are given in inches.
The American National Form of thread shall be used.
[1]Pitch diameter tolerances include errors of lead and angle.
[2]The maximum pitch diameters of screws are smaller than the minimum pitch diameters of nuts by these amounts.

Table by American Standards Association. Reprinted through courtesy of Crane Company's P. G. Schultz, and "Fasteners", published by the American Institute of Bolt, Nut, and Rivet Manufacturers, Cleveland, Ohio.

PRESSURE.....HIGH OR LOW

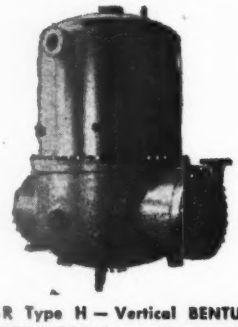
CAPACITY.....LARGE OR SMALL



G-R Type J-2—BENTUBE EVAPORATOR, for large capacities and high pressure.

There's a G-R BENTUBE EVAPORATOR for every requirement of boiler feed make-up

G-R Type N—BENTUBE EVAPORATOR, for moderate capacities and low pressure.



G-R Type H — Vertical BENTUBE EVAPORATOR, for small capacities.

No matter what size or type of boiler-feed make-up evaporator may be best suited for your particular plant conditions, an exactly suitable G-R BENTUBE EVAPORATOR is available for your precise requirements.

The design of these evaporators . . . based on 75 years of experience in building heat transfer apparatus . . . has several distinctive advantages assuring vapor that is both pure and dry, and with large overload capacity. In addition, these units have exclusive features that *maintain* rated capacity without the necessity of hand-scaling, and provide greatest ease of inspection and minimum attendance.

Bulletin 362 describes G-R BENTUBE EVAPORATORS in detail, explains in what plant conditions evaporators should be used, and analyzes their association with the plant heat balance. Your copy of this informative bulletin will be sent on request.

THE GRISCOM-RUSSELL CO.
285 MADISON AVENUE, NEW YORK 17, N. Y.

GRISCOM-RUSSELL

Pioneers in Heat Transfer Apparatus

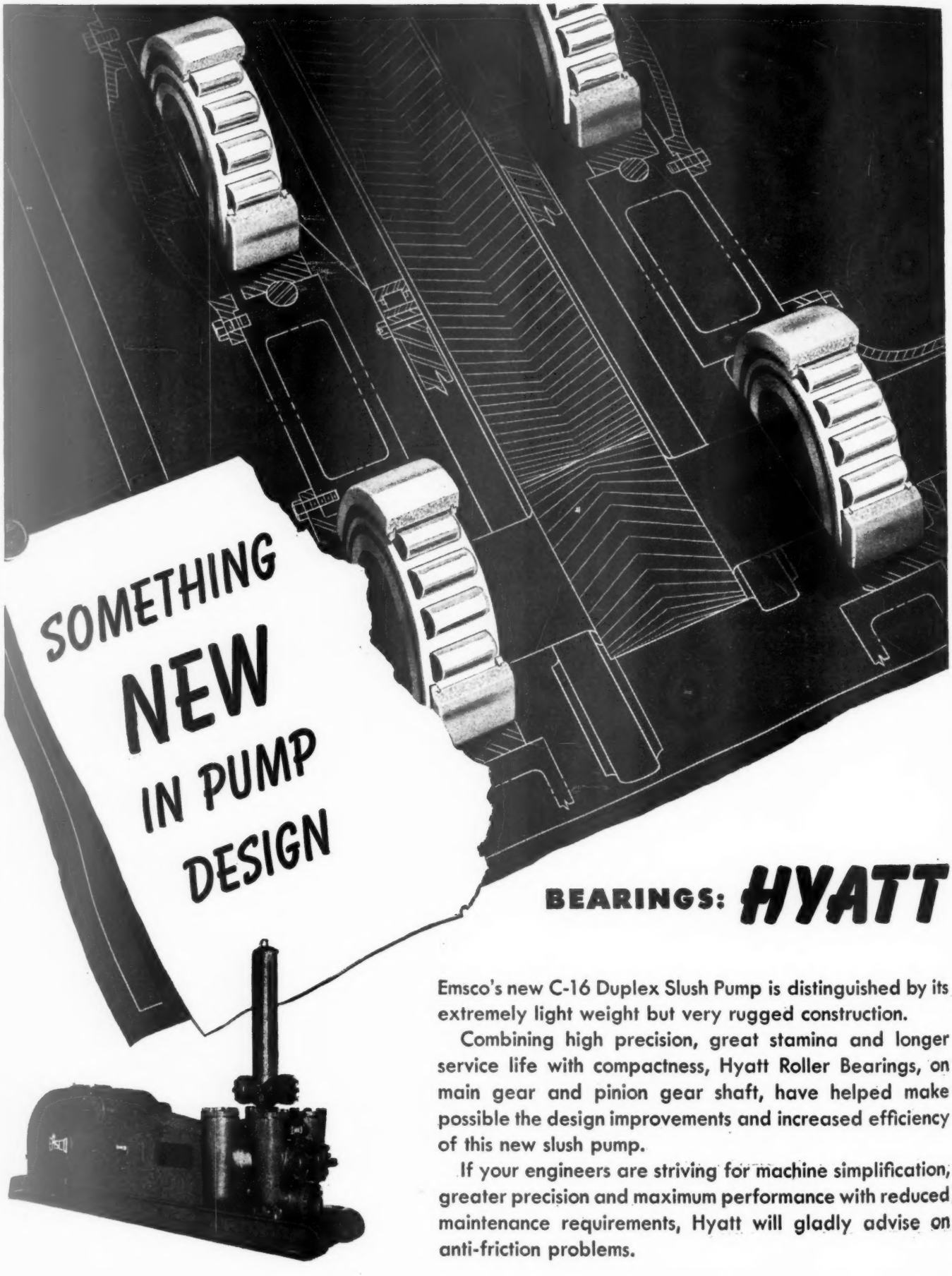
24-HOUR CAPACITY OF ORIFICE METERS*—FLANGE CONNECTIONS

Differential, 1 in. water. Base, 2-lb. Gravity, 0.60. Temperature, 60°F. Line diameter, 4 in.

Pressure lb. per sq. in. ga.	Size of orifice, in.											
	¼	½	¾	1	1¼	1½	1¾	2	2¼	2½	2¾	3
0	1.35	5.42	12.2	21.7	33.9	48.8	66.5	88.5	115.0	148.7	190.2	241.4
5	1.57	6.27	14.1	25.1	39.2	56.5	77.0	102.0	133.2	172.1	220.3	279.5
10	1.75	6.99	15.7	27.9	43.7	62.9	85.7	113.5	148.3	191.7	245.3	311.3
15	1.93	7.70	17.3	30.8	48.1	69.3	94.4	125.2	163.4	211.2	270.3	343.1
20	2.10	8.41	18.9	33.6	52.6	75.7	103.2	136.7	178.6	230.8	295.4	374.8
25	2.25	8.98	20.2	35.9	56.1	80.8	110.2	146.0	190.7	246.5	315.4	400.2
30	2.39	9.55	21.5	38.2	59.7	86.0	117.2	155.3	202.8	262.1	335.4	425.6
35	2.50	9.98	22.4	39.9	62.4	89.8	122.4	162.3	211.8	273.8	350.4	444.7
40	2.64	10.5	23.7	42.2	65.9	95.0	129.4	171.5	224.0	289.5	370.5	470.1
45	2.74	11.0	24.7	43.9	68.6	98.8	134.7	178.5	233.0	301.2	385.5	489.2
50	2.85	11.4	25.7	45.6	71.3	102.7	139.9	185.5	242.1	313.0	400.5	508.2
55	2.96	11.8	26.6	47.3	74.0	106.5	145.2	192.4	251.2	324.7	415.5	527.3
60	3.07	12.3	27.6	49.0	76.6	110.4	150.4	199.4	260.3	336.4	430.6	546.3
65	3.17	12.7	28.5	50.8	79.3	114.2	155.7	206.3	269.3	348.2	445.6	565.4
70	3.28	13.1	29.5	52.5	82.0	118.1	160.9	213.3	278.4	359.9	460.6	584.5
75	3.39	13.5	30.5	54.2	84.7	121.9	166.1	220.2	287.5	371.6	475.6	603.5
80	3.46	13.8	31.1	55.3	86.4	124.5	169.6	224.9	293.6	379.5	485.6	616.2
85	3.56	14.3	32.1	57.0	89.1	128.3	174.9	231.8	302.6	391.2	500.6	635.3
90	3.64	14.5	32.7	58.2	90.9	130.9	178.4	236.5	308.7	399.0	510.7	648.0
95	3.74	15.0	33.7	59.9	93.6	134.7	183.6	243.4	317.8	410.8	525.7	667.0
100	3.81	15.3	34.3	61.0	95.3	137.3	187.1	248.0	323.8	418.6	535.7	679.7
110	3.99	16.0	35.9	63.9	99.8	143.7	195.9	259.7	339.0	438.1	560.7	711.5
120	4.13	16.5	37.2	66.1	103.4	148.9	202.9	268.9	351.1	453.8	580.7	736.9
130	4.28	17.1	38.5	68.4	106.9	154.0	209.9	278.2	363.2	469.4	600.8	762.3
140	4.42	17.7	39.8	70.7	110.5	159.1	216.9	287.5	375.3	485.1	620.8	787.7
150	4.56	18.2	41.0	73.0	114.1	164.3	223.9	296.7	387.4	500.7	640.8	813.2
160	4.70	18.8	42.3	75.3	117.6	169.4	230.9	306.0	399.5	516.4	660.8	838.6
170	4.85	19.4	43.6	77.6	121.2	174.5	237.8	315.3	411.6	532.0	680.9	864.0
180	4.95	19.8	44.6	79.3	123.9	178.4	243.1	322.2	420.7	543.8	695.9	883.0
190	5.10	20.4	45.9	81.5	127.4	183.5	250.1	331.5	432.8	559.4	715.9	908.5
200	5.20	20.8	46.8	83.3	130.1	187.4	255.3	338.5	441.9	571.2	730.9	927.5
210	5.35	21.4	48.1	85.5	133.7	192.5	262.3	347.7	454.0	586.8	751.0	952.9
220	5.45	21.8	49.1	87.2	136.3	196.3	267.6	354.7	463.0	598.5	766.0	972.0
230	5.56	22.2	50.0	89.0	139.0	200.2	272.8	361.6	472.1	610.3	781.0	991.0
240	5.70	22.8	51.3	91.2	142.6	205.3	279.8	370.9	484.2	625.9	801.0	1016.
250	5.81	23.2	52.3	92.9	145.3	209.2	285.1	377.9	493.3	637.7	816.0	1036.
260	5.92	23.7	53.2	94.7	147.9	213.0	290.3	384.8	502.4	649.4	831.1	1055.
270	6.02	24.1	54.2	96.4	150.6	216.9	295.6	391.7	511.5	661.1	846.1	1074.
280	6.13	24.5	55.2	98.1	153.3	220.7	300.8	398.7	520.5	672.9	861.1	1093.
290	6.20	24.8	55.8	99.2	155.1	223.3	304.3	403.4	526.6	680.7	871.1	1105.
300	6.31	25.2	56.8	100.9	157.7	227.1	309.6	410.3	535.7	692.4	886.1	1124.
310	6.42	25.7	57.7	102.6	160.4	231.0	314.8	417.3	544.8	704.2	901.2	1144.
320	6.52	26.1	58.7	104.4	163.1	234.8	320.0	424.2	553.8	715.9	916.2	1163.
330	6.63	26.5	59.6	106.1	165.7	238.7	325.3	431.2	562.9	727.6	931.2	1182.
340	6.70	26.8	60.3	107.2	167.5	241.3	328.8	435.8	569.0	735.5	941.2	1194.
350	6.81	27.2	61.2	108.9	170.2	245.1	334.0	442.8	578.0	747.2	956.2	1213.
360	6.88	27.5	61.9	110.6	172.0	247.7	337.5	447.4	584.1	755.0	866.2	1226.
370	6.99	27.9	62.8	111.8	174.7	251.5	342.8	454.4	593.2	766.8	981.3	1245.
380	7.09	28.4	63.8	113.5	177.3	255.4	348.0	461.3	602.3	778.5	996.3	1264.
390	7.16	28.7	64.4	114.6	179.1	257.9	351.5	466.0	608.3	786.3	1006.	1277.
400	7.27	29.1	65.4	116.3	181.8	261.8	356.7	472.9	617.4	798.0	1021.	1296.

NOTE: Move decimal point to right for daily capacity at 100-in. water differential.

*Capacities are shown in thousands of cu. ft.



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Emsco's new C-16 Duplex Slush Pump is distinguished by its extremely light weight but very rugged construction.

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HYATT BEARINGS DIVISION, GENERAL MOTORS CORPORATION
HARRISON, NEW JERSEY

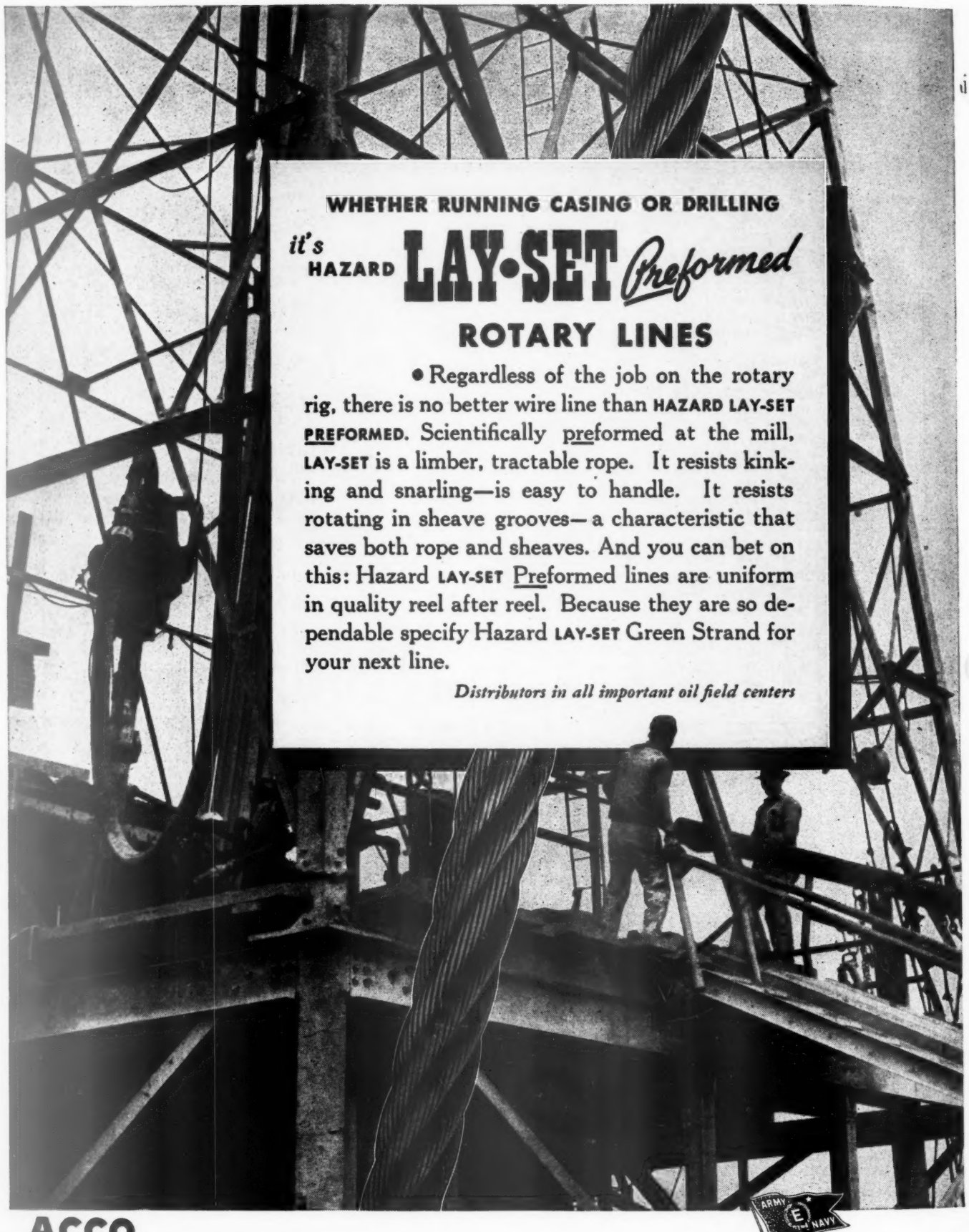
24-HOUR CAPACITY OF ORIFICE METERS*—FLANGE CONNECTIONS

Differential, 1 in. water. Base, 2-lb. Gravity, 0.60. Temperature, 60°F. Line diameter, 6 in.

Pressure lb. per sq. in. ga.	Size of orifice, in.											
	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	3¾	4	4½
0	48.8	66.4	86.7	109.7	135.4	164.7	198.2	236.8	282.2	334.4	394.6	543.1
5	56.5	76.8	100.4	127.0	156.8	190.7	229.5	274.2	326.7	387.2	456.9	628.8
10	62.9	85.6	111.8	141.5	174.6	212.4	255.5	305.4	363.9	431.2	508.9	700.3
15	69.3	94.3	123.2	155.9	192.5	234.1	281.6	336.6	401.0	475.2	560.8	771.8
20	75.7	103.0	134.6	170.3	210.3	255.7	307.7	367.7	438.1	519.2	612.7	843.2
25	80.8	110.0	143.7	181.9	224.5	273.1	328.6	392.7	467.8	554.5	654.2	900.4
30	85.9	117.0	152.8	193.4	238.8	290.4	349.4	417.6	497.5	589.7	695.8	957.6
35	89.8	122.3	159.7	202.1	249.5	304.4	365.1	436.3	519.8	616.1	726.9	1000.
40	94.9	129.2	168.8	213.7	263.7	320.7	385.9	461.2	549.5	651.3	768.5	1058.
45	98.8	134.5	175.6	222.3	274.4	333.7	401.6	479.9	571.8	677.7	799.6	1100.
50	102.6	139.7	182.5	231.0	285.1	346.8	417.2	498.6	594.0	704.1	830.8	1143.
55	106.5	145.0	189.3	239.6	295.8	359.8	432.9	517.3	616.3	730.5	861.9	1186.
60	110.3	150.2	196.1	248.3	306.5	372.8	448.6	536.0	638.6	756.9	893.1	1229.
65	114.2	155.4	203.0	257.0	317.2	385.8	464.2	554.7	660.9	783.3	924.2	1272.
70	118.0	160.7	209.8	265.6	327.9	398.8	479.8	573.4	683.2	809.7	955.4	1315.
75	121.9	165.9	216.7	274.3	338.6	411.8	495.4	592.1	705.4	836.1	986.6	1358.
80	124.4	169.4	221.2	280.1	345.7	420.4	505.9	604.6	720.3	853.7	1007.	1386.
85	128.3	174.6	228.1	288.7	356.4	433.4	521.5	623.3	742.6	880.1	1038.	1429.
90	130.9	178.1	232.6	294.5	363.5	442.1	532.0	635.7	757.4	897.7	1059.	1458.
95	134.7	183.4	239.5	303.2	374.2	455.1	547.6	654.4	779.7	924.1	1090.	1501.
100	137.3	186.9	244.0	308.9	381.3	463.8	558.0	666.9	794.5	941.7	1111.	1529.
110	143.7	195.6	255.4	323.4	399.2	485.5	584.1	698.1	831.7	985.7	1163.	1601.
120	148.9	202.6	264.6	334.9	413.4	502.8	605.0	723.0	861.4	1021.	1205.	1658.
130	154.0	209.6	273.7	346.5	427.7	520.1	625.8	747.9	891.1	1056.	1246.	1715.
140	159.1	216.6	282.8	358.0	441.9	537.5	646.7	772.9	920.8	1091.	1288.	1772.
150	164.3	223.5	291.9	369.6	456.2	554.8	667.5	797.8	950.5	1127.	1329.	1829.
160	169.4	230.5	301.1	381.1	470.4	572.1	688.4	822.7	980.2	1162.	1371.	1887.
170	174.5	237.5	310.2	392.7	484.7	589.5	709.3	847.7	1010.	1197.	1412.	1944.
180	178.4	242.8	317.0	401.3	495.4	602.5	724.9	866.4	1032.	1223.	1443.	1987.
190	183.5	249.7	326.1	412.9	509.7	619.8	745.8	891.3	1062.	1259.	1485.	2044.
200	187.4	255.0	333.0	421.5	520.3	632.8	761.4	910.0	1084.	1285.	1516.	2087.
210	192.5	262.0	342.1	433.1	534.6	650.2	782.3	934.9	1114.	1320.	1558.	2144.
220	196.3	267.2	349.0	441.7	545.3	663.2	797.9	953.6	1136.	1347.	1589.	2187.
230	200.2	272.5	355.8	450.4	556.0	676.2	813.6	972.3	1158.	1373.	1620.	2230.
240	205.3	279.4	364.9	462.0	570.2	693.5	834.4	997.2	1188.	1408.	1662.	2287.
250	209.2	284.7	371.8	470.6	580.9	706.5	850.1	1016.	1210.	1435.	1693.	2330.
260	213.0	289.9	378.6	479.3	591.6	719.5	865.7	1035.	1233.	1461.	1724.	2372.
270	216.9	295.2	385.4	487.9	602.3	732.5	881.4	1053.	1255.	1487.	1755.	2415.
280	220.7	300.4	392.3	496.6	613.0	745.5	897.0	1072.	1277.	1514.	1786.	2458.
290	223.3	303.9	396.8	502.4	620.1	754.2	907.4	1085.	1292.	1531.	1807.	2487.
300	227.1	309.1	403.7	511.0	630.8	762.2	923.1	1103.	1314.	1558.	1838.	2530.
310	231.0	314.4	410.5	519.7	641.5	780.2	938.7	1122.	1337.	1584.	1869.	2573.
320	234.8	319.6	417.4	528.4	652.2	793.2	954.4	1141.	1359.	1611.	1900.	2615.
330	238.7	324.8	424.2	537.0	662.9	806.2	970.0	1159.	1381.	1637.	1932.	2658.
340	241.3	328.3	428.8	542.8	670.0	814.9	980.5	1172.	1396.	1655.	1952.	2687.
350	245.1	333.6	435.6	551.5	680.7	827.9	9961.	1190.	1418.	1681.	1983.	2730.
360	247.7	337.1	440.2	557.2	687.9	836.5	1007.	1203.	1433.	1699.	2004.	2758.
370	251.5	342.3	447.0	565.9	698.5	849.5	1022.	1222.	1455.	1725.	2035.	2801.
380	255.4	347.5	453.9	574.6	709.2	862.5	1038.	1240.	1478.	1751.	2067.	2844.
390	257.9	351.0	458.4	580.3	716.4	871.2	1048.	1253.	1493.	1769.	2087.	2873.
400	261.8	356.3	465.3	589.0	727.1	884.2	1064.	1271.	1515.	1795.	2118.	2916.

NOTE: Move decimal point to right for daily capacity at 100-in. water differential.

*Capacities are shown in thousands of cu. ft.



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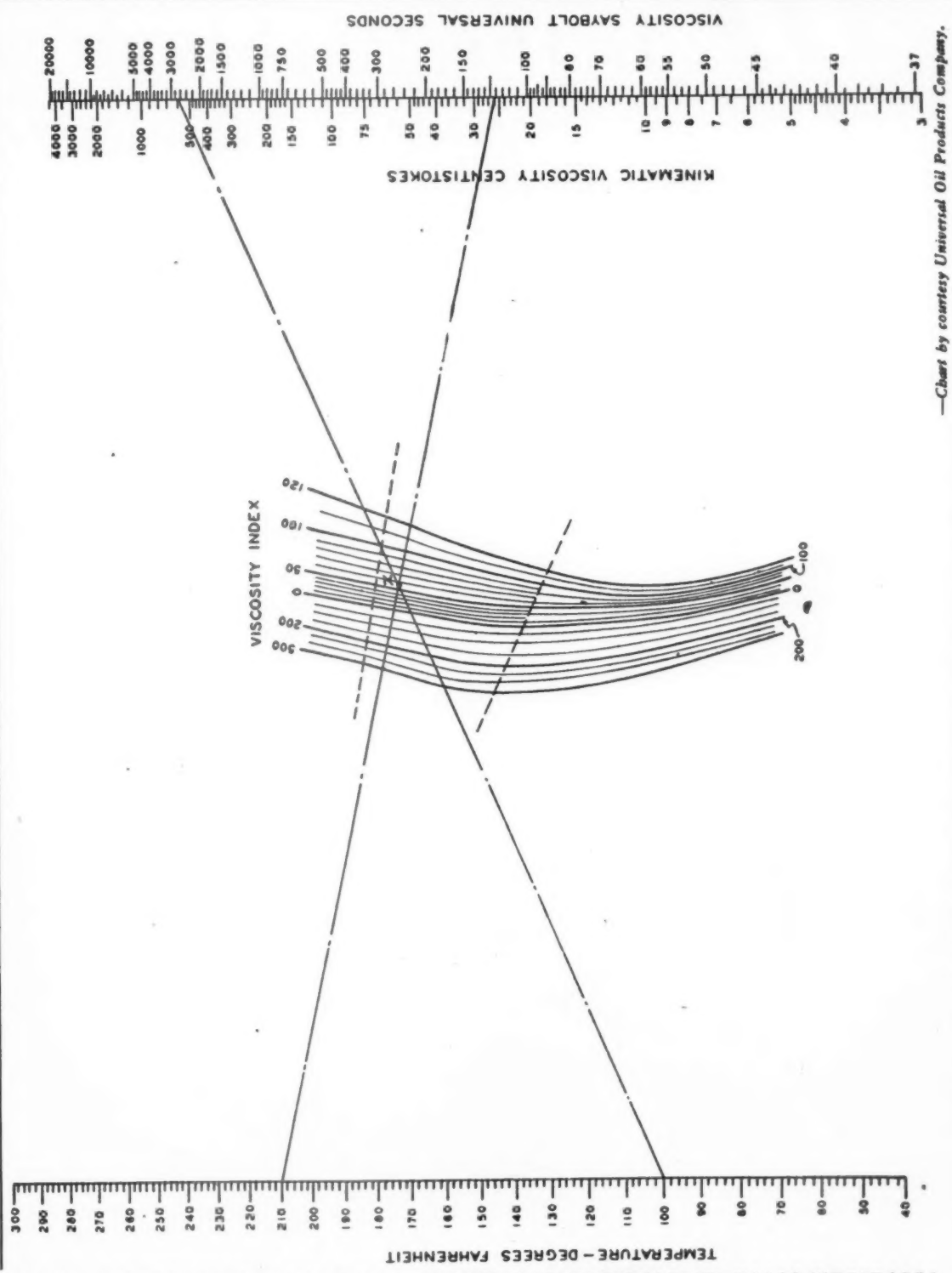
VISCOSITY INDEX CHART



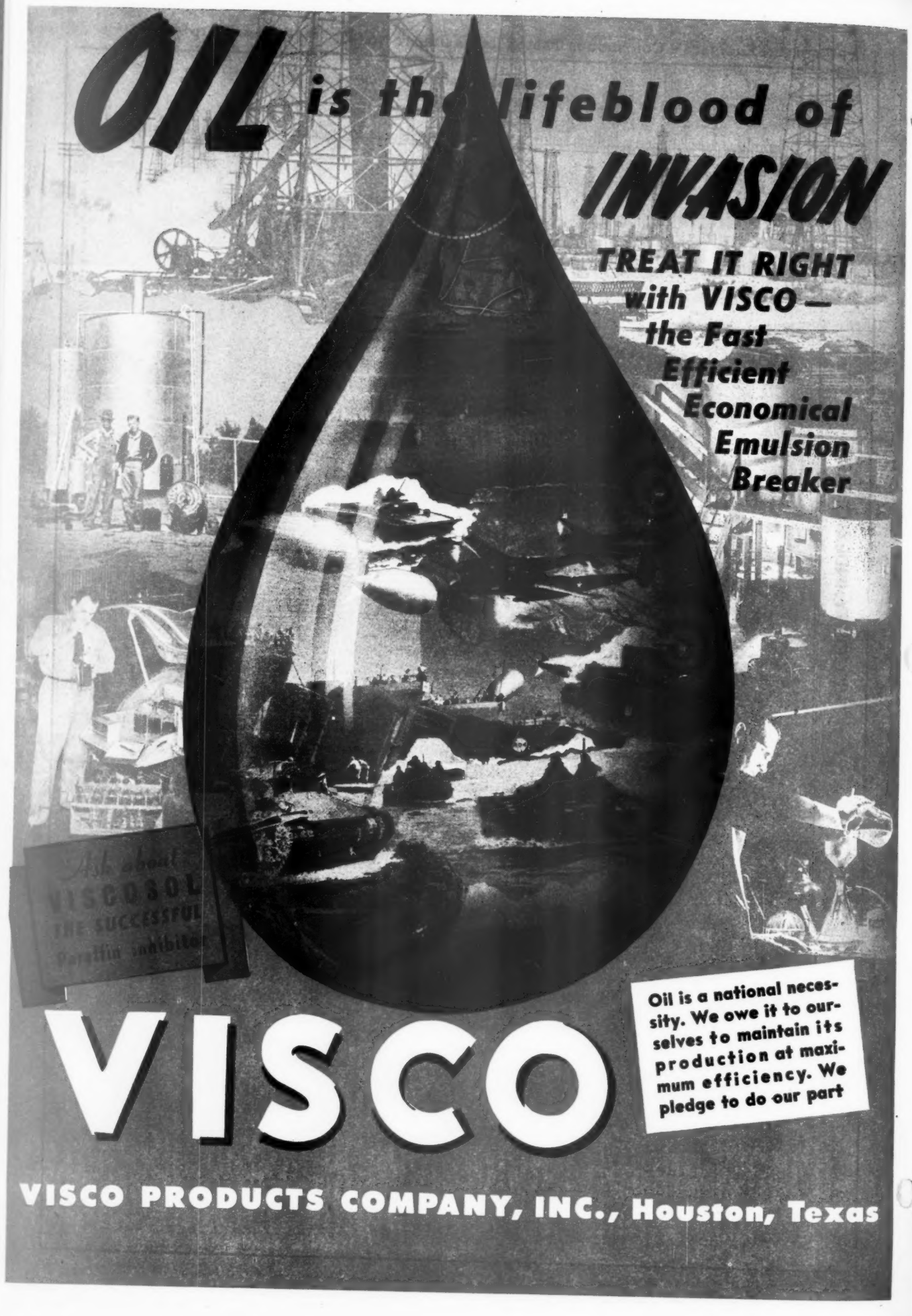
—Chart by courtesy Universal Oil Products Company.

The viscosity index chart was developed to extend the working range of the Dean and Davis viscosity index scale to heavier and lighter stocks than lubricating oils, and to provide a convenient means of viscosity index estimation from any two viscosity measurements within 40° to 300° F.

Example: The Saybolt Universal viscosities of an oil are 120 seconds at 210° F. and 2660 seconds at 100° F. A straight line is drawn between the 100° F. point on the left scale to the 2660 second point on the right scale. Similarly, the 210° F. point is connected by a straight line with 120 seconds. By interpolation between the curved lines in the center of the chart, the point of intersection X, of the drawn straight lines marks the viscosity index of the oil, approximately 55. The viscosity of this oil at any other temperature may be estimated by passing a straight edge through Point X, intercepting the viscosity scale at the viscosity corresponding to the intercept on the temperature scale.

Each curved line on the nomographic chart is the locus of index points corresponding to stocks of constant viscosity index. The portions of these lines lying between the two heavy broken lines were plotted directly from the data and formula of Dean and Davis. There is a slight disagreement between the viscosity indices in the chart and those of Dean and Davis stocks having viscosities between 40 and 45 seconds at 210° F. The curves from Dean and Davis did not join smoothly with the data on lighter stocks in this region. As a result, the viscosity indices of oils in this range are slightly higher when read from the chart than when calculated from the Dean and Davis equation.

Viscosity indices can be read from this chart with an accuracy proportional to the experimental accuracy of the viscosity determinations. In the 60-120 viscosity index range, the estimation from the chart should agree with the Dean and Davis calculated value to within a difference of viscosity index of 5. The use of the Dean and Davis formula indicates an accuracy in the lower range of the viscosity index scale which is unwarranted by the experimental accuracy.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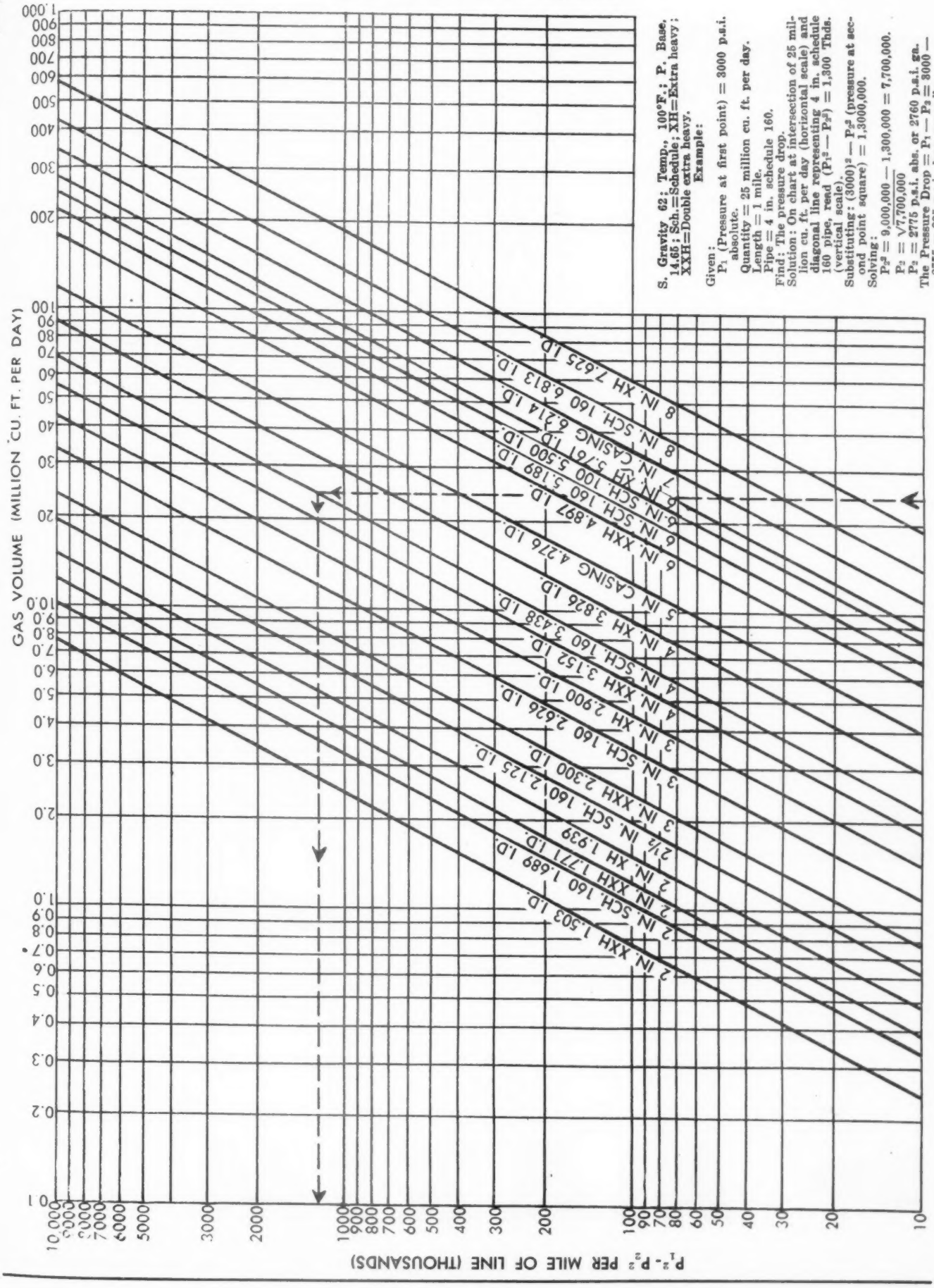
CURVES FOR ESTIMATING PRESSURE DROP IN HIGH PRESSURE GAS PIPE LINES

Based on Weymouth Flow Equation.

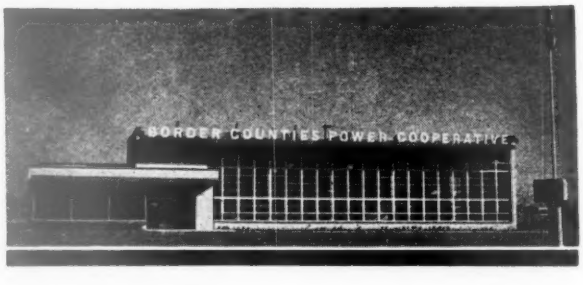

S. Gravity 62; Temp., 100°F.; P. Base, 14.65; Sch.=Schedule; XH=Extra heavy; XXH=Double extra heavy.
Example:
Given:
P1 (Pressure at first point) = 3000 p.s.i. absolute.
Quantity = 25 million cu. ft. per day.
Length = 1 mile.
Pipe = 4 in. schedule 160.
Find: The pressure drop.
Solution: On chart at intersection of 25 million cu. ft. per day (horizontal scale) and diagonal line representing 4 in. schedule 160 pipe, read (P1² — P2²) = 1,300 Thds. (vertical scale).
Substituting: (3000)² — P2² (pressure at second point square) = 1,3000,000.
Solving:
P2² = 9,000,000 — 1,300,000 = 7,700,000.
P2 = √7,700,000
P2 = 2775 p.s.i. abs. or 2760 p.s.i. ga.
The Pressure Drop = P1 — P2 = 3000 — 2775 = 225 p.s.i. drop per mile.
8 IN. XH 7.625 I.D.
8 IN. SCH. 160 6.813 I.D.
8 IN. CASING 6.214 I.D.
6 IN. XH 5.761 I.D.
6 IN. SCH. 160 5.500 I.D.
6 IN. XXH 5.189 I.D.
5 IN. CASING 4.897 I.D.
4 IN. XH 4.276 I.D.
4 IN. SCH. 160 3.826 I.D.
4 IN. XXH 3.438 I.D.
3 IN. XH 3.152 I.D.
3 IN. SCH. 160 2.900 I.D.
3 IN. XXH 2.626 I.D.
2½ IN. SCH. 160 2.300 I.D.
2½ IN. XH 2.125 I.D.
2 IN. XXH 1.939 I.D.
2 IN. SCH. 160 1.771 I.D.
2 IN. XXH 1.689 I.D.
2 IN. XXH 1.503 I.D.
GAS VOLUME (MILLION CU. FT. PER DAY)
P1² - P2² PER MILE OF LINE (THOUSANDS)

HOW TO PUT WASTE HEAT TO WORK

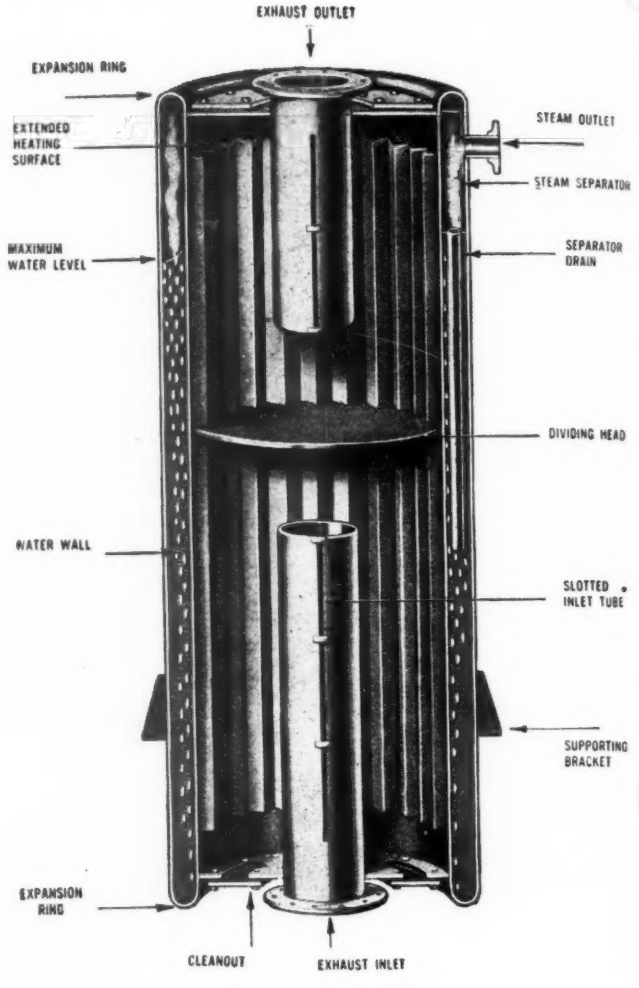
WITH MAXIM HEAT RECOVERY SILENCERS

Engine exhaust heat, all too often wasted, can be put to good and profitable use through Maxim Heat Recovery Silencers. With these specially constructed silencers extra steam or hot water for heating or processing operations is obtained *without extra fuel cost* as the heat source is simply engine exhaust heat. Thus in one unit effective exhaust silencing, spark arresting (where necessary) and heat recovery are combined for maximum operating efficiency. Such a saving, important to your balance sheet at any time, is doubly important where fuel supplies are difficult to obtain.

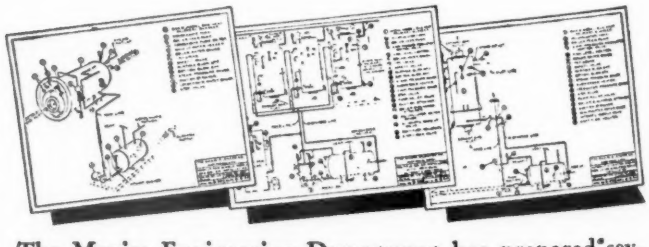
The power plant below located in northern Minnesota is heated entirely through the use of Maxim Heat Recovery Silencers.



For silencing, without the heat recovery feature, Maxim makes silencers for internal combustion engine exhaust or intake, steam engine exhaust, air compressor intake, vacuum pump discharge, blower intake and discharge, high velocity steam, air or gas discharge. Engine exhaust silencers available with or without spark arrestor. Bulletins on request.



PRACTICAL WORKING HOOK-UPS



The Maxim Engineering Department has prepared several drawings of typical Heat Recovery Silencer hook-ups. These are available with a detailed discussion of each hook-up. We will be glad to send them to you. Just ask for Dwgs. B-298, B-301, B-302 and B-303.

ARMY E NAVY

MAXIM

THE MAXIM SILENCER CO. • 90 HOMESTEAD AVE., HARTFORD, CONN.

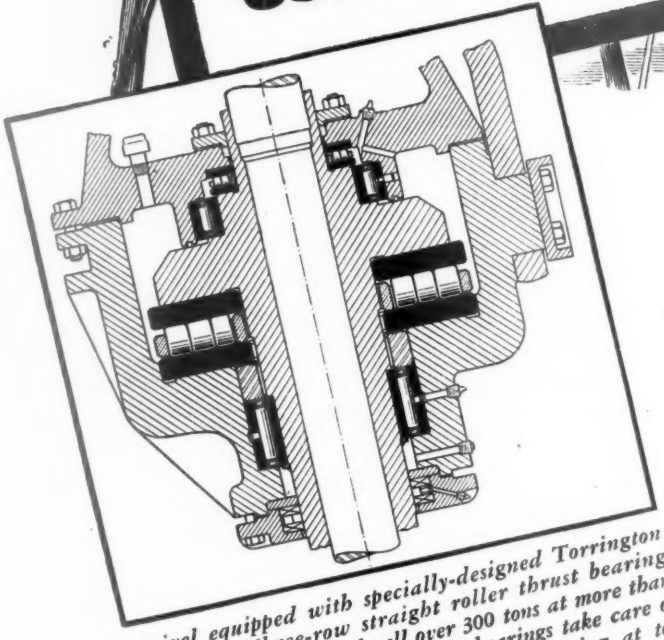
CHARCOAL TESTING METER FACTORS FOR G.P.M.

C. C.	Factor	C. C.	Factor	C. C.	Factor	C. C.	Factor	C. C.	Factor
1.0	0.26420	8.0	2.11360	15.0	3.96300	22.0	5.81240	29.0	7.66180
.1	.29062	.1	2.14002	.1	3.98942	.1	5.83882	.1	7.68822
.2	.31704	.2	2.16644	.2	4.01584	.2	5.86524	.2	7.71464
.3	.34346	.3	2.19286	.3	4.04226	.3	5.89166	.3	7.74106
.4	.36988	.4	2.21928	.4	4.06868	.4	5.91808	.4	7.76748
1.5	0.39630	8.5	2.24570	15.5	4.09510	22.5	5.94450	29.5	7.79390
.6	.42272	.6	2.27212	.6	4.12152	.6	5.97092	.6	7.82032
.7	.44914	.7	2.29854	.7	4.14794	.7	5.99734	.7	7.84674
.8	.47556	.8	2.32496	.8	4.17436	.8	6.02376	.8	7.87316
.9	.50198	.9	2.35138	.9	4.20078	.9	6.05018	.9	7.89958
2.0	0.52840	9.0	2.37780	16.0	4.22720	23.0	6.07660	30.0	7.92600
.1	.55482	.1	2.40422	.1	4.25362	.1	6.10302	.1	7.95242
.2	.58124	.2	2.43064	.2	4.28004	.2	6.12944	.2	7.97884
.3	.60766	.3	2.45706	.3	4.30646	.3	6.15586	.3	8.00526
.4	.63408	.4	2.48348	.4	4.33288	.4	6.18228	.4	8.03168
2.5	0.66050	9.5	2.50990	16.5	4.35930	23.5	6.20870	30.5	8.05810
.6	.68692	.6	2.53632	.6	4.38572	.6	6.23512	.6	8.08452
.7	.71334	.7	2.56274	.7	4.41214	.7	6.26154	.7	8.11094
.8	.73976	.8	2.58916	.8	4.43856	.8	6.28796	.8	8.13736
.9	.76618	.9	2.61558	.9	4.46498	.9	6.31438	.9	8.16378
3.0	0.79260	10.0	2.64200	17.0	4.49140	24.0	6.34080	31.0	8.19020
.1	.81902	.1	2.66842	.1	4.51782	.1	6.36722	.1	8.21662
.2	.84544	.2	2.69484	.2	4.54424	.2	6.39364	.2	8.24304
.3	.87186	.3	2.72126	.3	4.57068	.3	6.42006	.3	8.26946
.4	.89828	.4	2.74768	.4	4.59708	.4	6.44648	.4	8.29588
3.5	0.92470	10.5	2.77410	17.5	4.62350	24.5	6.47290	31.5	8.32230
.6	.95112	.6	2.80052	.6	4.64992	.6	6.49932	.6	8.34872
.7	.97754	.7	2.82694	.7	4.67634	.7	6.52574	.7	8.37514
.8	1.00396	.8	2.85336	.8	4.70276	.8	6.55216	.8	8.40156
.9	1.03038	.9	2.87978	.9	4.72918	.9	6.57858	.9	8.42798
4.0	1.05680	11.0	2.90620	18.0	4.75560	25.0	6.60500	32.0	8.45440
.1	1.08322	.1	2.93262	.1	4.78202	.1	6.63142	.1	8.48042
.2	1.10964	.2	2.95904	.2	4.80844	.2	6.65784	.2	8.50724
.3	1.13606	.3	2.98546	.3	4.83486	.3	6.68426	.3	8.53366
.4	1.16248	.4	3.01189	.4	4.86128	.4	6.71068	.4	8.56008
4.5	1.18990	11.5	3.03830	18.5	4.88770	25.5	6.73710	32.5	8.58650
.6	1.21532	.6	3.06472	.6	4.91412	.6	6.76352	.6	8.81292
.7	1.24174	.7	3.09114	.7	4.94054	.7	6.78994	.7	8.63934
.8	1.26816	.8	3.11756	.8	4.96696	.8	6.81636	.8	8.66576
.9	1.29458	.9	3.14398	.9	4.99338	.9	6.84278	.9	8.69218
5.0	1.32100	12.0	3.17040	19.0	5.01980	26.0	6.86920	33.0	8.71860
.1	1.34742	.1	3.19682	.1	5.04622	.1	6.89562	.1	8.74502
.2	1.37384	.2	3.22324	.2	5.07264	.2	6.92204	.2	8.77144
.3	1.40026	.3	3.24966	.3	5.09906	.3	6.94846	.3	8.79786
.4	1.42668	.4	3.27608	.4	5.12548	.4	6.97488	.4	8.82428
5.5	1.45310	12.5	3.30250	19.5	5.15190	26.5	7.00130	33.5	8.85070
.6	1.47952	.6	3.32892	.6	5.17832	.6	7.02772	.6	8.87712
.7	1.50594	.7	3.35534	.7	5.20474	.7	7.05414	.7	8.90354
.8	1.53236	.8	3.38176	.8	5.23116	.8	7.08056	.8	8.92996
.9	1.55878	.9	3.40818	.9	5.25758	.9	7.10698	.9	8.95638
6.0	1.58520	13.0	3.43460	20.0	5.28400	27.0	7.13340	34.0	8.98280
.1	1.61162	.1	3.46102	.1	5.31042	.1	7.15982	.1	9.00922
.2	1.63804	.2	3.48744	.2	5.33684	.2	7.18624	.2	9.03564
.3	1.66446	.3	3.51386	.3	5.36326	.3	7.21266	.3	9.06206
.4	1.69088	.4	3.54028	.4	5.38968	.4	7.23908	.4	9.08848
6.5	1.71730	13.5	3.56670	20.5	5.41610	27.5	7.26550	34.5	9.11490
.6	1.74372	.6	3.59312	.6	5.44252	.6	7.29192	.6	9.14132
.7	1.77014	.7	3.61954	.7	5.46894	.7	7.31834	.7	9.16774
.8	1.79656	.8	3.64596	.8	5.49536	.8	7.34476	.8	9.19416
.9	1.82298	.9	3.67238	.9	5.52178	.9	7.37118	.9	9.22058
7.0	1.84940	14.0	3.69880	21.0	5.54820	28.0	7.39760	35.0	9.24700
.1	1.87582	.1	3.72522	.1	5.57462	.1	7.42402	.1	9.27342
.2	1.90224	.2	3.75164	.2	5.60104	.2	7.45044	.2	9.29984
.3	1.92866	.3	3.77806	.3	5.62746	.3	7.47686	.3	9.32626
.4	1.95508	.4	3.80448	.4	5.65388	.4	7.50328	.4	9.35268
7.5	1.98150	14.5	3.83090	21.5	5.68030	28.5	7.52970	35.5	9.37910
.6	2.00792	.6	3.85732	.6	5.70672	.6	7.55612	.6	9.40552
.7	2.03434	.7	3.88374	.7	5.73314	.7	7.58254	.7	9.43194
.8	2.06076	.8	3.91016	.8	5.75956	.8	7.60896	.8	9.45836
.9	2.08718	.9	3.93658	.9	5.78598	.9	7.63538	.9	9.48478

The factors in the chart above divided by the cu. ft. run through the charcoal testing meter will give the G.P.M. of the gas tested.

$$\frac{0.2642 \times \text{C.C.}}{\text{Cu. Ft. Run}} = \frac{\text{Factor}}{\text{Cu. Ft. Run}} = \text{G.P.M.}$$

WHERE THE HEAT'S ON
USE TORRINGTON BEARINGS



Swivel equipped with specially-designed Torrington Bearings. Three-row straight roller thrust bearing handles thrust loads of well over 300 tons at more than 300 RPM. Two single-row roller bearings take care of radial load; small double-row thrust bearing at top carries weight of the swivel.

Today, more than ever, "the heat's on" in the oil fields...drilling speeds are faster, loads heavier, depths greater... and rotary swivels must take greatly increased radial and thrust loads.

That's why, especially where the going is toughest, you find swivels equipped with Torrington Bearings. Precision-built for uniform load distribution, Torrington anti-friction bearings are easy to lubricate and maintain. They help you drill faster and deeper... stand up to today's increased loads...give you long, efficient performance under all conditions.

Torrington's Bantam Bearings Division has years of specialized experience in designing and manufacturing bearings for oil field equipment. Our engineers will gladly consult with you regarding your needs, present or future.

THE TORRINGTON COMPANY · BANTAM BEARINGS DIVISION
SOUTH BEND 21, INDIANA

TORRINGTON BEARINGS

STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL

STRAIGHT SCREW THREADS FOR HIGH-TEMPERATURE BOLTING

Limiting Dimensions and Tolerances for Threads on Nuts

Sizes	Threads per inch	Minor diameter			Pitch diameter			Major diameter, min.
		Max.	Min.	Tolerance	Max.	Min.	Tolerance[1]	
A	B	M	N	P	R	S	T	C
¼	20	0.2060	0.1959	0.0101	0.2211	0.2175	0.0036	0.2500
5/16	18	0.2630	0.2524	0.0106	0.2805	0.2764	0.0041	0.3125
3/8	16	0.3184	0.3073	0.0111	0.3389	0.3344	0.0045	0.3750
7/16	14	0.3721	0.3602	0.0119	0.3960	0.3911	0.0049	0.4375
½	13	0.4290	0.4167	0.0123	0.4552	0.4500	0.0052	0.5000
9/16	12	0.4850	0.4723	0.0127	0.5140	0.5084	0.0056	0.5625
5/8	11	0.5397	0.5266	0.0131	0.5719	0.5660	0.0059	0.6250
¾	10	0.6553	0.6417	0.0136	0.6914	0.6850	0.0064	0.7500
7/8	9	0.7689	0.7547	0.0142	0.8098	0.8028	0.0070	0.8750
1	8	0.8795	0.8647	0.0148	0.9264	0.9188	0.0076	1.0000
1⅛	8	1.0045	0.9897	0.0148	1.0517	1.0438	0.0079	1.1250
1¼	8	1.1295	1.1147	0.0148	1.1771	1.1688	0.0083	1.2500
1⅜	8	1.2545	1.2397	0.0148	1.3024	1.2938	0.0086	1.3750
1½	8	1.3795	1.3647	0.0148	1.4278	1.4188	0.0090	1.5000
1⅝	8	1.5045	1.4897	0.0148	1.5531	1.5438	0.0093	1.6250
1¾	8	1.6295	1.6147	0.0148	1.6785	1.6688	0.0097	1.7500
1⅞	8	1.7545	1.7397	0.0148	1.8038	1.7938	0.0100	1.8750
2	8	1.8795	1.8647	0.0148	1.9292	1.9188	0.0104	2.0000
2⅛	8	2.0045	1.9897	0.0148	2.0545	2.0438	0.0107	2.1250
2¼	8	2.1295	2.1147	0.0148	2.1798	2.1688	0.0110	2.2500
2½	8	2.3795	2.3647	0.0148	2.4305	2.4188	0.0117	2.5000
2¾	8	2.6295	2.6147	0.0148	2.6812	2.6688	0.0124	2.7500
3	8	2.8795	2.8647	0.0148	2.9318	2.9188	0.0130	3.0000
3¼	8	3.1295	3.1147	0.0148	3.1820	3.1688	0.0132	3.2500
3½	8	3.3795	3.3647	0.0148	3.4321	3.4188	0.0133	3.5000

For use with pressure vessels and steel pipe flanges, fittings and valves.
All dimensions are given in inches.
The American National Form of thread shall be used.
[1]Pitch diameter tolerances include errors of lead and angle.

Table by American Standards Association. Reprinted through courtesy of Crane Company's P. G. Schultz, and "Fasteners", published by the American Institute of Bolt, Nut, and Rivet Manufacturers, Cleveland, Ohio.

Instrument Air *must be* CLEAN AIR!

Remember! Only a Nash Compressor can supply Clean Air!

Because Nash Compressors have no internal lubrication and because delivered air is thoroughly washed within the pump, the Nash delivers only clean air, free from dust, heat, or oil. Therefore, instrument air supplied by a Nash assures immediate instrument response and eliminates all troubles resulting from fouled instrument lines, gummed orifices, and rotting instrument diaphragms. Also avoided are trouble and expense of the usual oil filters, dust filters, and after coolers, as none are used. Nash means dependable, low cost instrument operation.

Nash Compressors produce 75 lbs. pressure in a single stage, capacities to 6 million cubic feet a day in a single structure. No valves, gears, pistons, sliding vanes, or other enemies of long life complicate a Nash. Original capacity is maintained throughout a long life. Investigate the Nash Compressor now.

No internal lubrication to contaminate air handled.

No internal wearing parts.

No valves, pistons, or vanes.

75 lbs. pressure or 26 in. mercury vacuum in one stage.

Non-pulsating pressure.

Original performance constant over a long pump life.

Low maintenance cost.

NASH ENGINEERING COMPANY
335 WILSON, SO. NORWALK, CONN.

Running Tour WITH MEN IN THE INDUSTRY

Walter Von Atta, superintendent at Coalinga and **L. E. Evans,** superintendent at Long Beach, of Shamrock Drilling Company of Los Angeles, California, are starting a new 10-well program at Coalinga, California, for Standard Oil Company. Their main offices are in the Petroleum Building at Los Angeles.

W. Page Keeton has been appointed as assistant chief counsel of PAW, Deputy Petroleum Administrator Ralph K. Davies has announced. Keeton was price executive of the petroleum price branch of OPA from September 1944 until his recent appointment. He joined the OPA staff in June, 1942, as chief counsel of that agency's petroleum price board. From April, 1944, to September, 1944, he was counsel of the OPA fuel division.

Donald J. Reese, who has been with the steel division, WPB, since April, 1942, has resumed his duties with the development and research division of The International Nickel Company, Inc., New York City.

Frank H. Stone is now resident engineer at the La Gloria Corporation Plant at Falfurrias, Texas. He was formerly with The Shamrock Oil and Gas Corporation of Amarillo.

Henry Emmett Gross has joined the staff of the Kingwood Oil Company, Effington, Illinois, to handle their petroleum engineering work. Formerly he was chief of the reservoir engineering section of PAW, District 2, having been with that agency since the war began. Prior to that he was associate professor of petroleum engineering at A&M College of Texas and the University of Oklahoma. He holds a degree from the Missouri School of Mines, and has had experience in petroleum engineering and oil field work in Kansas, Oklahoma, Texas, Illinois, and California.

Harvey Menard has been appointed sales and service engineer for the Crosby Steam Gage and Valve Company, Inc., 2034 Santa Fe Avenue, Los Angeles, California, according to an announcement by George H. Cristen, Pacific Coast manager. He will operate throughout the Pacific Coast area. A graduate of the University of Washington in chemical engineering, Menard was formerly with the Bechtel-McCone-Parsons Corporation as process engineer.

Harvey Menard

Dr. Frank M. Surface has been appointed executive assistant to the president of Standard Oil Company (New Jersey), Eugene Holman, president, has announced. Dr. Surface has been coordinator of sales research for the company since 1943, prior to which he was director of sales research for 10 years for its domestic operating subsidiary, Standard Oil Company of New Jersey. From 1927 to 1933 he served as assistant director of the bureau of foreign and domestic commerce in the Department of Commerce.

Governor Robert S. Kerr of Oklahoma is shown affixing his signature to House Bill No. 133 providing for permanent levy from the Oklahoma gross production tax for the maintenance of the Interstate Oil Compact and the Oklahoma Conservation Department of the Corporation Commission. The passage of this bill by unanimous votes in both houses of the Oklahoma Legislature, as a permanent law, indicates the progress the Commission has made.

R. L. Minckler, former head of the division of petroleum supply for PAW has been elected a vice president of General Petroleum Corporation, according to S. J. Dickey, president. Starting with General Petroleum in 1924, Minckler rose in the corporation until, at the time he was loaned to the government, he was assistant to the president, a director, and chairman of the supply committee. He became a director in 1941.

Northrop Clarey, assistant to the president of Standard Oil Company (New Jersey) for the last 9 years, has resigned that post but will continue with the company on special duties, Eugene Holman, president, has announced. Clarey has been with Jersey Standard for more than a quarter of a century and is widely known through his association with various public activities of the company. He was formerly associated with the National City Company and the *Wall Street Journal* and was at one time financial editor of *The New York Times*.

S. F. Shaw, consulting engineer and expert in the gas-lift method of producing oil, is again associated with the petroleum engineering department, A&M College of Texas, as professor of petroleum engineering. He plans to complete research started some time ago on the capacities of producing oil strings.

Lt. Colonel A. B. Stevens, recently promoted to this rank, is now with the Military Pipe Line Group in Paris, France. Col. Stevens was a professor of petroleum engineering at the A&M College of Texas before entering the armed services and is on leave from the college while serving with the army.

C. L. Brockschmidt has joined the staff of the Standard Oil Company of New Jersey as gas engineer in foreign marketing coordination, with offices in New York City. Since March, 1942, he has been connected with WPB as a natural gas engineer, serving for the last 18 months as chief of the supply and allocation section. Previous to going with WPB, Brockschmidt was employed by the Mississippi River Fuel Corporation, St. Louis, Missouri, and by the Lone Star Gas Company, Dallas, Texas.

U. E. Sandelin has been appointed manager of the Allis-Chalmers Manufacturing Company's Seattle, Washington, district office, according to Frank Angle, manager. He succeeds **A. J. Schmitz,** who has been named Pacific regional manager. Before being appointed to the Seattle office, Sandelin was attached to the Allis-Chalmers district office in Washington, D. C. Schmitz was manager of the Allis-Chalmers office at Portland, Oregon.

J. H. Hayter, assistant purchasing agent of Tide Water Associated Oil Company in charge of the department's Los Angeles office, was guest of honor recently at a dinner where his associates presented him with a scroll in commemoration of his 35 years' service with the company.

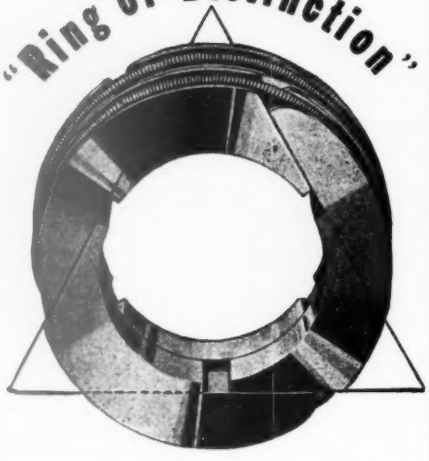
George O. Suman, superintendent of production and development for Tide Water Associated Oil Company, San Joaquin Valley district, Bakersfield, California, has been appointed national chairman of the Pacific Coast district of API's division of production. Suman with long experience in the producing branch of the petroleum industry, succeeds the late W. L. Jarvis of The Texas Company.

George O. Suman

R. N. Duncan, Shell Oil employe since 1927, has been appointed acting manager of the supplies department. In 1933 he became head yield clerk in the

FOR THE DEFENSE OF DEMOCRACY
THE BEST IS NONE TOO GOOD

FRANCE PACKING
has a "Ring of Distinction"



Imitated but never duplicated, the France ring is manufactured in three sections. The contacting faces form the lines of an equilateral triangle. As the ring is expanded or contracted, the sections must move in or out radially equal distances from the center of the rod to which the ring is fitted. This fundamental mechanical principle accounts for the efficiency, trouble-free performance and extra-long life of France Metal Packing.

After years of service, when the rings have become worn to such an extent that the sections nearly butt together, further years of additional service can be obtained by cutting off the narrow points of the three sections where they form a part of the inner circumference of the ring. The spring then requires adjustment so that the sections are held to the rod with a slight tension.

For installation in engines, pumps and compressors—under all conditions of service, France Full-floating Metal Packing means true economy in the long run.
Permit France Engineers to analyze your packing requirements.

Write for Catalog M-3

ORIGINAL FRANCE METAL PACKING
Sold on approval
Satisfaction Guaranteed

THE FRANCE PACKING COMPANY
Tacony Philadelphia 35 Penna.
Mid-Continent Representative:
MR. J. M. FULLER, 3725 West 7th Street
FORT WORTH, TEXAS

Original FRANCE METAL PACKING

main office at the refinery and 2 years later was appointed senior clerk in the manufacturing department in St. Louis. He was later appointed assistant manager of the T&S supply department, in charge of the Mid-Continent area.

▸ **E. C. Reece** has been named superintendent of the newly established Wasson-Hobbs division of Shell Pipe Line Corporation's Texas-Gulf area. The new division includes operations in Lea County, New Mexico. Reece joined Shell in 1928 and was for 4 years district foreman. He was acting division superintendent at Healdton, Oklahoma, for a year and has recently been a supervisor-counselor in the personnel department. **T. V. Venator** has been appointed Texas-Gulf area construction supervisor. He has been superintendent of the East Texas division of Shell Pipe Line. Venator has been a maintenance, construction, and operating supervisor throughout his 18 years with Shell. **A. F. Terrill** has succeeded Venator as superintendent of the East Texas division. He has been with the company for 25 years and has served in various managerial positions. **C. P. Wilson** has been named superintendent of Shell Pipe Line's Healdton division. He has been a supervisor with the company for more than 18 years, including 13 with an affiliate company in Mexico. During the past 2 years he has been foreman in the Baytown district of the Bayou Pipe Line System.

▸ **A. W. Chandler,** formerly chief mechanical engineer for Engineering Laboratories, Inc., is now associated with The Refinery Supply Company, according to President W. A. Schlueter. Chandler will be active in the department of gas engineering specialties that are manufactured by the company.

A. W. Chandler

▸ **M. E. "Cap" Miller** has recently been promoted from district representative to central sales manager, offices in Peoria, Illinois, according to an announcement by R. G. LeTourneau, Inc. A veteran of the construction field, Miller joined LeTourneau in 1934 and served as district representative for domestic sales in eastern Canada. In this new position, Miller will supervise the activities of LeTourneau district representatives in approximately 20 middlewestern states. He succeeds **Howard L. Stilley,** who becomes manager of Soule's Equipment Company, exclusive northern California distributor for R. G. LeTourneau, Inc.

▸ **H. P. Arbuckle,** formerly secretary-treasurer of Neches Butane Products Company, has been promoted to vice president and secretary. He is a 25-year man with Gulf Oil Corporation, from which company he is on leave of absence. **I. H. Foshee,** new vice president in charge of manufacturing, is an addition to the executive staff of the company. For the last 2 years he has been associated with Rubber Reserve Company. He is also a Gulf employe, on leave. **F. W. Cooper,** former assistant treasurer of the company, has been promoted to treasurer. He is on leave from The Texas Company for the purpose of aiding in the synthetic rubber program.

▸ **R. Henquet** has returned to the Schlumberger Well Surveying Corporation in the capacity of vice president and general manager with headquarters at the main office, Houston, Texas, following his release from the army. Henquet has filled various executive positions with Schlumberger. Immediately prior to his entrance into the service he was executive vice president of International Cementers, Inc.

▸ **John W. Pegg** has been appointed manager of the head office legal department of Shell Oil Company. He is a graduate of the Missouri University School of Law and for 4 years after leaving college served as law clerk to Judge Kimbrough Stone, presiding judge of the United States Court of Appeals for the 8th Circuit. He joined Shell in 1937 and was transferred to the legal department in New York in 1940.

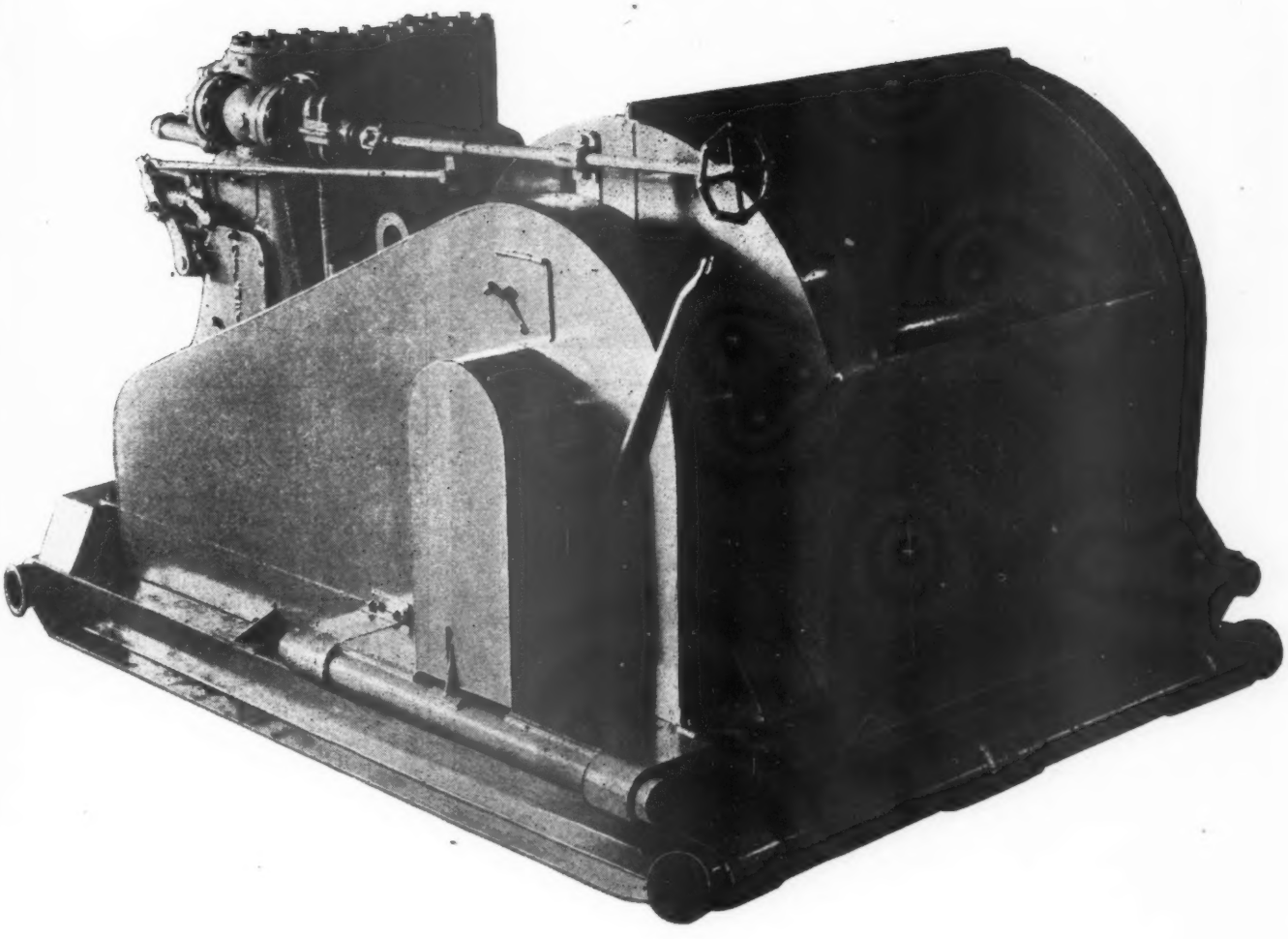
▸ **Hollis B. Fairchild** has been appointed associate director of PAW's supply and transportation division on the west coast. He succeeds **A. C. Saul,** who is returning to the Shell Oil Company, Inc. Fairchild goes to PAW from his position as general manager of operations of the Standard Oil Company of California with which he has been associated for 32 years.

▸ **Milton N. Weir,** formerly assistant division manager of the New York division of Gulf Oil Corporation, has been made assistant to W. V. Hartmann, vice president in charge of sales of the company. Weir's new offices will be at 120 Broadway, New York City. **E. D. Rohrback** has been appointed assistant division manager of the New York division of the company succeeding Weir.

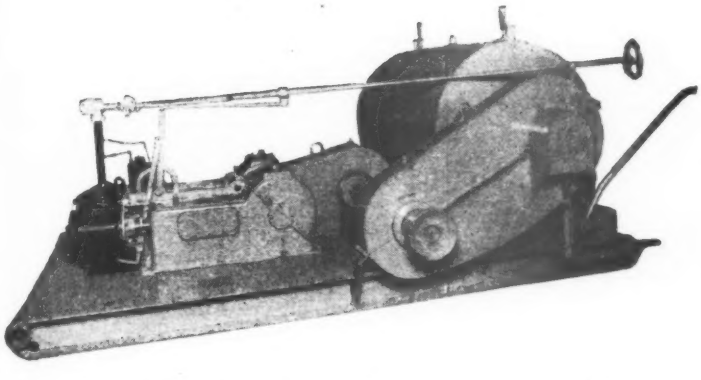
▸ **N. R. Patterson,** president of Patterson Steel Company, has been elected to the position of first vice president of the Chamber of Commerce, Tulsa, Oklahoma. He replaces **R. L. Ledterman.**

▸ **Lt. Stafford Park** is back as sales manager for the Eastman Oil Well Survey Corporation, Long Beach, California, following his release to inactive duty with the aviation and engineering branches of the navy. Park was granted relase to participate in the essential-type war production being done by the company, now largely manufacturing oil field production specialties.

▸ **William F. Thiede** has been appointed manager of the New Jersey Works of Standard Oil Company of New Jersey, succeeding the late G. H. Mettam, it has been announced by J. R. Carringer, general manager of the company's East Coast manufacturing operations. Thiede has been with the company nearly 33 years, starting as an errand boy in 1909 during school vacations. He was made



Hunt Unitized Wire Line Coring Reel and Engine



Furnished with vertical type engine, as shown in top photograph . . . or with horizontal type, as shown immediately above.

Designed for heavy duty coring operations on today's deepest holes. 50" reel has line capacity of 15,750' of ⅝" line . . . 11,200' of ¾" line. 16" drum center speeds up line travel. Equipped with self-aligning roller bearings, provisioned for Alemite lubrication. Positive acting brake mechanism has 1360 square inches of effective band area for each brake.

Compact design of complete unit saves derrick floor space.

HUNT TOOL COMPANY

FIELD SHOPS: Houston, Bay City, Corpus Christi, Jennings, Harvey, Casper

HUNT TOOL COMPANY

A BUSINESS BUILT ON *Good* SERVICE

HARRISBURG

Much greater strength, reduction in weight, lower machining costs and uniform physical properties.

The Big Three of the Oil Fields. Harrisburg oil field products are right from the start because they are made from steel produced in Harrisburg's open hearth furnaces.

H

HARRISBURG STEEL CORPORATION

Established 1853

HARRISBURG, PENNSYLVANIA

SEAMLESS STEEL PRODUCTS

HARRISBURG MAKES: Alloy and Carbon Steel; Seamless Steel Cylinders, Liquefiers, Pipe Couplings and Sleeve Pump Liners; Drop Forgings and Drop-Forged Steel Pipe Flanges; Coils and Bends.

assistant superintendent in 1926 at Bayway in charge of atmospheric distillation and oil movement and storage, was appointed assistant general superintendent in 1936, and later general superintendent. Since 1944 he has been assistant manager of the New Jersey Works.

▸ **R. E. Old, Jr.** has recently resigned as manager of the bottom-hole engineering department of Core Laboratories, Inc., to accept a position as engineer with Socony-Vacuum Company of Venezuela.

▸ **James A. Lewis,** president of Core Laboratories since 1936, has recently been elected a director of Highland Park State Bank. Lewis lives in Dallas, Texas, is a member of the Dallas Petroleum Club, Dallas Petroleum Engineers Club, and American Association Petroleum Geologists. He was graduated from the Pennsylvania State College where he majored in petroleum engineering.

▸ **L. E. Hanson,** assistant comptroller of Socony-Vacuum Oil Company, Inc., has been loaned to the RFC, Price Adjustment Board, to develop data and information required in connection with renegotiation of government contracts with the oil industry, his company has announced. He is the first member of the petroleum industry to be called by RFC for this work. He has been with Socony-Vacuum for 20 years and has held his present position since 1938.

▸ **Fayette B. Dow** has resigned as director of the liquid transport department, ODT. **Porter Howard,** formerly deputy director, succeeded him on March 1. Dow will resume oil industry activities.

▸ **C. H. Keplinger,** member of the petroleum engineering firm of Keplinger and Wanenmacher of Tulsa, Oklahoma, recently presented a paper entitled "Progress in Oil Conservation" to a group of members and guests of the East Texas section of AIME. The paper was given at a dinner at Kilgore, Texas. Keplinger outlined the history and future outlook of oil conservation. The treatise will be presented at the annual AIME meeting in New York City.

▸ **W. B. Holton, Jr.,** president of Walworth Company, manufacturers of valves and fittings, was elected president of The Valve Manufacturers Association, a national organization, at a meeting held at the Biltmore Hotel, New York City, on February 9.

▸ **L. F. Campbell** was elected vice president in charge of maunfacturing, precision gear division, Foote Brothers Gear and Machine Corporation, Chicago. Other officers elected were **R. B. Moir,** assistant vice president in charge of sales engineering, industrial gear division; **E. A. Johnson,** assistant vice president in charge of manufacturing, industrial gear division; **I. C. McVicar,** assistant secretary, and **L. J. Malina,** assistant treasurer.

▸ **George R. Carr** was elected chairman of the board of directors of the Dearborn Chemical Company, Chicago, at a special meeting of the directors recently. He succeeds the late **Robert F. Carr.**

CASING PROTECTORS • STABILIZERS • PIPE WIPERS • WIRE LINE GUIDES • WIRE LINE WIPERS • KELLY WIPERS
KELLY SUB PROTECTORS • MUD GUNS • MUD GUN NOZZLES • SWIVEL BAIL BUMPERS • DEAD LINE STABILIZERS
TRAVELING BLOCK BUMPERS • TUBING PROTECTORS • SUCKER ROD WIPERS • TUBING WIPERS

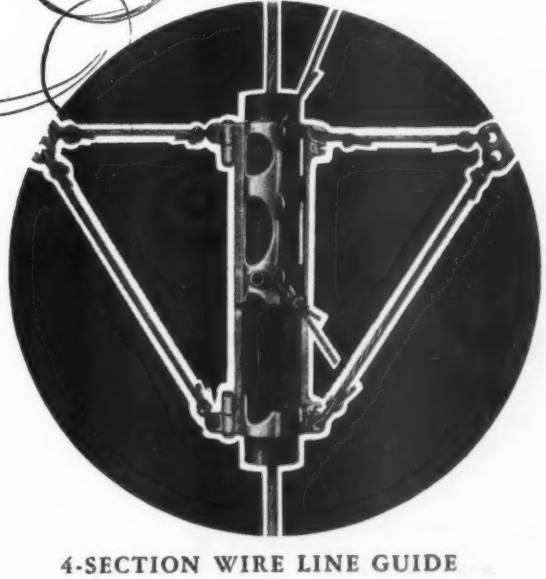
ARE THESE *Imps* ON YOUR PAYROLL?

Why tolerate line "jitters"? Take these imps off your payroll! Remember "jitters" in your wire line speed the process of fatigue and wear and tear on your equipment.

That's where PATTERSON-BALLAGH Wire Line Guides come into the picture. They bridle your line with a resilient sleeve bearing of long wearing PBX synthetic rubber that reduces "vibration" and "whip" and irons out the "travel wave." By stabilizing the line, the guide permits even spooling plus a reduction of strand wear and kinking. Drilling and wire line speeds can be increased and life of the line expanded from 10% to 50%.

For tall derricks, 2 guides are recommended, one just above the drum and the other just below the crown. Available in 2, 4 and 6-section units, for various types of application. Initial cost is moderate. Maintenance cost is low, as the replaceable refills are the only wearing parts.

See Composite Catalog



4-SECTION WIRE LINE GUIDE

Patterson-Ballagh WIRE LINE GUIDES
NOW MADE OF PBX SYNTHETIC RUBBER
OIL AND WEATHER RESISTANT

"But Bet Yet"
PATTERSON-BALLAGH
LOS ANGELES 1 • HOUSTON 10 • NEW YORK 6

Tube Borium Keeps 'em digging

DULL IN 3 DAYS
STILL SHARP AFTER 30 DAYS
STOODY TUBE BORIUM KEEPS DITCHER TEETH SHARP ... ELIMINATES FREQUENT SHUT-DOWNS FOR TOOTH CHANGES ... CUTS REPLACEMENT COSTS UP TO 75%

The two ditcher teeth pictured above were used on the same machine and operated under identical conditions.
The unprotected tooth at the top had to be sharpened every three days and was too short for further service after six sharpenings.
But the Borium-protected tooth at the bottom operated for 40 days and wore only ½". It was simply resharpened in the forge, retipped with Tube Borium, and put back on the ditcher for another 40 days' service.
Before the tooth was finally worn out, it had operated a total of 120 days!
Tube Borium makes such savings possible because the deposits represent the ultimate in wear resistance and the ability to cut hard earth formations.

*Stoody Tube Borium is supplied in rods of ⅛", 5/32", ¼" and ⅜" diameters and is available for either oxyacetylene or D.C. electric application. Prices and specifications are yours for the asking.

These tungsten carbide particles do not melt when tube is applied but are held in suspension in a mild steel matrix forming a deposit resembling coarse sandpaper.

Send for free booklet on TUBE BORIUM, showing sizes and styles of rods and recommended methods of application.

STOODY COMPANY
1142 West Slauson Ave., Whittier, Calif.

STOODY HARD-FACING ALLOYS
Stop wear ... Eliminate Repair

LAUGH WITH BARNEY

The WAC private had gone for a walk in the country near her camp. It was a hot day, so when she came to a pool a little off the road and surrounded by trees, she decided to have a dip.

She folded her clothes on the bank and jumped in, swam around for a while, and then scrambled out.

As she did so she saw an Army officer approaching and hid behind one of the trees. He came nearer and nearer, and suddenly called out: "Camouflage platoon, dismiss!"

Whereupon all the trees walked away!

* * *

"I thought you were a woman-hater, how is it I saw you with one last night?"

"I just hang around 'em to keep myself mad."

* * *

A recruit was running the obstacle course, puffing and groaning, when finally he fell down.

"What's the trouble?" demanded the chief.

"I think I've broken my leg, Sir," the seaman moaned.

"Well, don't just lie there and waste time," shouted the chief. "Start doing push-ups."

* * *

Blonde: Would you call it mental telepathy if we were thinking of the same thing?

Sailor: No. Just plain good luck.

* * *

Camp Doc: Private Jones swallowed his knife, Sir, and we've operated for its recovery without success.

Major: Okay, issue Jones another one.

* * *

Private: I see my friend gave you a black eye, Sergeant.

Top Kick: Listen, runt, you never seen the guy that hung this lamp on me.

Private: Well, he's my friend now.

* * *

Jimmy, age 8, was assigned by his teacher to write a piece about his origin. Seeking cooperation, he questioned his mother.

"Mom, where did Grandma come from?"

"The stork brought Grandma, darling."

"Well, where did you come from?"

"The stork brought me, too."

"And—me?"

"And you, too, dear."

Resignedly the young modern wrote the lead for his composition: "There have been no natural births in our family for three generations."

* * *

An optimist is a man who marries his secretary thinking he'll be able to keep on dictating to her.

* * *

A Scotchman walked up to a friend at the bar and began telling him about a hunting trip.

"We got a couple of bears," he said, "but the biggest thrill was tracking yuers."

"What's yuers?" asked the friend.

"I'll have a beer, thanks," replied the Scotchman.

Just as they reached the bottom of their glasses the friend remarked, "Well, I'll have to go home and do my chores."

"What chores?" asked the Scotchman.

"Beer, please," said the other.

* * *

Merchant: These are especially strong shirts, madam. They simply laugh at the laundry.

Customer: I know that kind. I had some that came back with their sides split.

"When I left Camp Dix I didn't owe anyone a cent."

"What an unfortunate time to leave!"

* * *

"I sure told that sergeant exactly what I thought of him!"

"But Ed says he was there, and that you said nothing."

"Er—well, that's exactly what I think of him!"

* * *

First Marine: When in China did you take a ride in one of those jinrikishas?

Second Marine: Yes, and they have horses that look just like men.

* * *

Glamour is something that evaporates when the sweater is a little too large.

* * *

Girl Friend: I'm getting so thin you can count my ribs.

Boy Friend: Gee! Thanks!

* * *

A comely colored girl had just been baptized in the river. As she came to the surface she cried, "Bless de Lawd, Ise saved! Las' night I was in the ahms of Satan, but tonight A'm in de ahms of de Lawd!"

"Sistuh," came a baritone voice from the shore, "how is you all fixed up for tomorra ebening?"

* * *

A family with a summer cottage in a Wisconsin wilderness habitually paid the requested price of 50 cents to an Indian for a milk pail full of blueberries. But one day last summer he suddenly grunted in protest and upped the price to a dollar.

"Why?" they asked in amazement.

"Hell of a big war some place," was the laconic reply.

* * *

A bricklayer working on top of a high building carelessly dropped a brick on the head of his negro helper below.

"Youall bettah be careful up dere," the helper shouted up. "You done made me bite mah tongue."

* * *

The officer gazed sternly at the private who had been brought before him.

"Did you call the sergeant a liar?"

"I did, sir."

"And a twister?"

"Yes, sir."

"And did you go on to describe him as a pop-eyed, knock-kneed, black-blighted stooge?"

The private hesitated. Then, with a note of regret in his voice said, "No, sir, I forgot that."

* * *

"I hear the officers are trying to stop necking near the WAVE barracks."

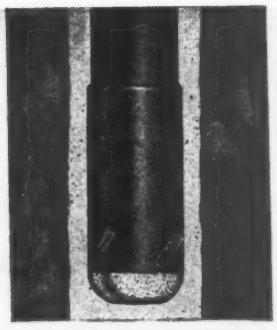
"Is that so ... first thing you know they'll be trying to make the enlisted men stop, too."

* * *

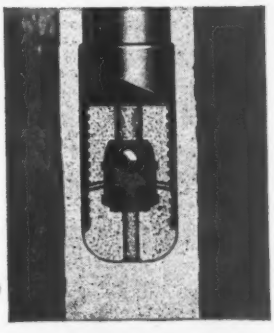
Abraham was a total flop as a rookie. Efforts to teach him anything about the army were in vain. However, he was taken along when his outfit went overseas and the first day of action he was the most outstanding soldier in the entire company, wiping out six machine gun nests single-handed. The commanding officer was amazed and asked his top sergeant for a possible explanation.

"Just what did you do to make Abraham change so quickly from a total flop to a good soldier," he asked the sergeant.

"All I did, sir," replied the sergeant, "was to stick a machine gun in his hands just before the battle and say: 'Abe, from now on you are in business for yourself'."

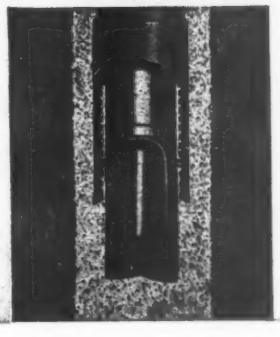


• It will safely guide and float the longest and heaviest string of casing.



• It has a positive acting *Ball-Type* Back Pressure Valve.

• It provides *Whirling action* which assures best possible cement distribution around the shoe with minimum hazard of channeling.

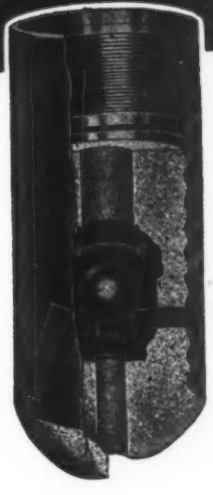


• It affords easy drillability.

Better Cementing

A first time cement job today, is not merely desirable, it is a "must". War requirements demand all possible conservation of critical materials as well as proper and efficient use of available manpower. No job therefore should be done a second time if it is possible to accomplish results on the first effort.

Baker's contribution in this direction is making available cementing devices which afford best possible assurance of doing the job *right* and doing it *the first time*. One such "first-time" cementing device is illustrated below.



Product 120

BAKER CEMENT WASH-DOWN WHIRLER FLOAT SHOE

For complete details concerning Baker Cement Wash-Down Whirler Float Shoes and other efficient Baker Cement Guiding, Floating, Cementing Units, see pages 303-313 of the 1944 Baker, or Composite Catalog.

BAKER CEMENT GUIDING, FLOATING, CEMENTING EQUIPMENT

BAKER OIL TOOLS, INC.

Houston—LOS ANGELES—New York

Baker Cement Float Shoe
Baker Cement Float Collar
Product No. 100
Product No. 101 M&F
Baker Cement Guide Casing Shoe
Product No. 102
Baker Cement Wash-Down Whirler Float Shoe
Product No. 120
Baker Cement Wash-Down Whirler Guide Shoe
Product No. 121
Baker Cement Whirler Float Collar with Solid Bottom Baffle with Metal "Petal" Basket
Product No. 306

CORRELATION OF GAS-OIL RATIO, YIELD, AND CONTENT

By **K. MARSHALL FAGIN**, *Field Editor*

EXCLUSIVE Most oil and gas production men, especially engineers, are interested in keeping the *gas-oil ratios* of oil wells down to a minimum, and the *barrels per million* or *gallons per thousand* of gas wells up to a maximum, but many do not realize the relationships that exist between these customary *expressions of the gas-liquid ratios.*

These relationships may be expressed as follows:

(a) *in terms of gas-oil ratio:*

$$\text{Gas-oil ratio}_{\text{(cu. ft. per bbl.)}} = \frac{\text{bbl. per million}}{1{,}000{,}000} = \frac{42{,}000}{\text{gal. per thousand}}$$

(b) *in terms of yield:*

$$\text{Barrels per million} = \frac{1{,}000{,}000}{\text{gas-oil ratio}} = \frac{\text{gal. per thousand}}{0.042}$$

(c) *in terms of content:*

$$\text{Gallons per thousand} = \frac{42{,}000}{\text{gas-oil ratio}} = \frac{(0.042)\ (\text{bbl. per million})}{1}$$

The gas-oil ratio terminology. The gas-oil ratio of an oil well is usually stated as a number of cubic feet per barrel, such as 1500 to 1, or just 1500. The majority of oil wells have lower gas-oil ratios when first completed than after they have been produced for many months or several years. Under controlled producing rates, however, the gas-oil ratios may be held to a minimum, thus saving the gas in solution in the reservoir, where it helps to increase the ultimate recovery of oil. In some fields the ratios of oil wells may range from 300 to 1000 cu. ft. per barrel. In others, the range may be from 500 to 100,000 cu. ft. per barrel, on account of a gas cap in the oil reservoir.

Conversion of gas-oil ratio to barrels per million. In fields like the last, the wells would range from good low-ratio oil wells to gas wells whose high gas-oil ratios, or yields, would probably be expressed as a certain number of *barrels per million* or *gallons per thousand.* Let us convert the 500 cu. ft. gas-oil ratio to barrels per million:

Equation: $\text{Bbl. per million} = \frac{1{,}000{,}000}{\text{gas-oil ratio}}$

Substituting: $\text{Bbl. per million cu. ft.} = \frac{1{,}000{,}000}{500}$

Answer: Bbl./MMCF = 2000

In other words, an oil well producing with a gas-oil ratio of 500 cu. ft. per bbl. could correctly be said to be producing 2000 bbl. of oil per million cu. ft. of gas. Observe carefully the different notations used in the above example. Barrels per million may be written in several abbreviated ways:

(1) Bbl. per million,
(2) Bbl. per million cu. ft.
(3) Bbl./MMCF, or more simply,
(4) BPMM

Similarly, *gas-oil ratio* may be abbreviated in several ways:

(1) gas-oil ratio,
(2) gas/oil ratio,
(3) cu. ft. per bbl. ratio, or
(4) GOR.

Next, let us convert the 100,000 GOR to barrels per million:

$\text{Bbl. per million cu. ft.} = \frac{1{,}000{,}000}{100{,}000} = 10$ BPMM

Conversion to gallons per thousand. We have found, then, that a gas-oil ratio range of from 500 to 100,000 cu. ft. per bbl. is the same as a barrel per million range of from 2000 to 10. Now, let us find what these figures mean in the *gallons per thousand* language:

Equation: $\text{Gal. per thousand} = \frac{42{,}000}{\text{gas-oil ratio}}$

Substituting: $\text{Gal./MCF} = \frac{42{,}000}{500}$

Answer: GPM = 84

In other words, an oil well producing with a gas-oil ratio of 500 cu. ft. per bbl. could be correctly said to be producing 84 gal. of oil per thousand cu. ft.

Observe the different notations used in the above example. *Gallons per thousand* may be written in several abbreviated ways:

(1) Gal. per thousand,
(2) Gal./MCF,
(3) GPM.

Next, let us convert the 100,000 GOR to gal. per thousand:

$\text{Gal./thousand} = \frac{42{,}000}{100{,}000} = 0.42$ GPM

We have found, then, three different ways for correctly expressing the facts

TABLE 1

Factors of equal value in the three terminologies.

Gas-oil ratio (cu. ft./bbl.)	Yield (bbl./M.M.C.F.)	Content (gal/M.C.F.)
500,000	2.00	0.084
450,000	2.22	0.093
400,000	2.50	0.105
375,000	2.67	0.112
350,000	2.86	0.120
325,000	3.08	0.129
300,000	3.33	0.140
290,000	3.45	0.145
280,000	3.57	0.150
270,000	3.70	0.155
260,000	3.85	0.161
250,000	4.00	0.168
240,000	4.17	0.175
230,000	4.35	0.183
220,000	4.55	0.191
210,000	4.76	0.200
200,000	5.00	0.210
190,000	5.26	0.221
180,000	5.55	0.233
170,000	5.88	0.247
160,000	6.25	0.263
150,000	6.67	0.280
140,000	7.14	0.300
130,000	7.69	0.323
120,000	8.33	0.350
110,000	9.09	0.382
100,000	10.00	0.420
95,000	10.53	0.442
90,000	11.11	0.467
85,000	11.76	0.494
80,000	12.50	0.525
75,000	13.33	0.560
70,000	14.29	0.600
65,000	15.38	0.646
60,000	16.67	0.700
55,000	18.18	0.764
50,000	20.00	0.840
49,000	20.41	0.857
48,000	20.83	0.875
47,000	21.28	0.894
46,000	21.74	0.913
45,000	22.22	0.933
44,000	22.73	0.954
43,000	23.26	0.977
42,000	23.81	1.000
41,000	24.39	1.024
40,000	25.00	1.050
39,000	25.64	1.077
38,000	26.32	1.105
37,000	27.03	1.135
36,000	27.78	1.167
35,000	28.57	1.200
34,000	29.41	1.235
33,000	30.30	1.273
32,000	31.25	1.312
31,000	32.26	1.355
30,000	33.33	1.400
29,000	34.48	1.448
28,000	35.71	1.500
27,000	37.04	1.555
26,000	38.46	1.615
25,000	40.00	1.680
24,000	41.67	1.750
23,000	43.48	1.826
22,000	45.45	1.909
21,000	47.62	2.000
20,000	50.00	2.100
19,000	52.63	2.210
18,000	55.55	2.333
17,000	58.82	2.470
16,000	62.50	2.625
15,000	66.67	2.800
14,000	71.43	3.000
13,000	76.92	3.231
12,000	83.33	3.500
11,000	90.91	3.818
10,000	100.00	4.200
9,000	111.11	4.667
8,000	125.00	5.250
7,000	142.86	6.000
6,000	166.67	7.000
5,000	200.00	8.400
4,000	250.00	10.500
3,000	333.33	14.000
2,000	500.00	21.000
1,000	1000.00	42.000
900	1111.11	46.667
800	1250.00	52.500
700	1428.57	60.000
600	1666.67	70.000
500	2000.00	84.000
400	2500.00	105.000
300	3333.33	140.000
200	5000.00	210.000
100	10000.00	420.000

MODEL 6-WAK WAUKESHA ENGINE. Burns gas or gasoline. Six cylinders, 6¼ in. bore x 6½ in. stroke, 1197 cu. in. displacement. Rugged . . . to the last fine detail . . . from oil pan to head. Maintenance is easy and economical.

IN THIS LARGE CYCLING PLANT

. . . water circulation pumps are **powered** by 12

WAUKESHA *Oil Field* ENGINES

● Installed by the Petroleum Equipment Co. of Los Angeles . . . twelve Super Duty Six Waukesha Engines . . . in two pump houses . . . circulate the process water used for cooling throughout this large cycling plant in California. It is one of the first plants of this kind in that area.

These Waukesha Super Duty Sixes are natural gas burning Model 6-WAK engines—direct connected to Ingersoll-Rand Cameron 10-ALV pumps, running 950 r.p.m. 17″ vacuum, used to circulate water through engine and compressor jackets. Built to deliver maximum power, on either gas or gasoline, this is *the* engine for tomorrow's pumps, generators, oil field and mobile heavy-duty equipment. *Get Bulletin 1138.*

WAUKESHA MOTOR COMPANY, WAUKESHA, WIS. • NEW YORK, TULSA, LOS ANGELES

about the range of gas-liquid ratios in the field:

Range	
First Fact	*Second Fact*
500 cu. ft./bbl.	100,000 cu. ft./bbl.
2000 bbl./MMCF	10 bbl./MMCF
84 gal./MCF	0.42 gal./MCF

Customary uses of these terms. The *gas-oil ratio terminology* is used customarily for expressing the facts concerning oil wells that ordinarily produce with gas-oil ratios ranging from 300 up to 10,000 cu. ft. per bbl. The term, *barrels per million*, or *the yield*, is used generally for expressing the facts concerning gas-condensate wells that commonly produce with yields of from 10 to 100 barrels per million cu. ft. The term *gallons per thousand*, or *the content*, is customarily used for expressing the facts concerning gas wells that usually produce gas with contents of from 0.2 to 5.0 gal. per 1000 cu. ft.

Regardless of the customary usages, the increasing development of high gas-oil ratio oil wells and low gas-condensate ratio gas wells has tended to bring these terms together, and a clear understanding of their correlation should prove helpful to field men and operators who may be confronted with identical situations expressed in various ways.

Table 1 should be useful in determining the similarity or dissimilarity of facts as expressed in the three terminologies here discussed. ★★★

Lufkin officials

At the annual meeting of stockholders and directors of the Lufkin Foundry and Machine Company, Lufkin, Texas, Walter W. Trout was named vice president and general manager; L. A. Little, vice president in charge of sales, and E. H. Bounds, treasurer. E. P. Trout and L. A. Little were added to the list of vice presidents.

A. E. Cudlipp, vice president in charge of purchases and the Industrial Supply Division, and Jacque Wiener of Shreveport, were added to the board of directors. Other directors are W. C. Trout, president, J. H. Kurth, Jr., vice president, E. L. Kurth, W. W. Trout, L. A. Little, and S. W. Henderson, Jr.

L. A. Little, named sales manager, has long been identified with the Lufkin company, for many years having been in charge of the company's Dallas office.

E. P. Trout, newly elected vice president, has been in charge of California sales for the last 10 years. Trout will continue to direct California sales and, in addition, will supervise foundry operations at the Lufkin plant.

W. W. Trout

A. E. Cudlipp

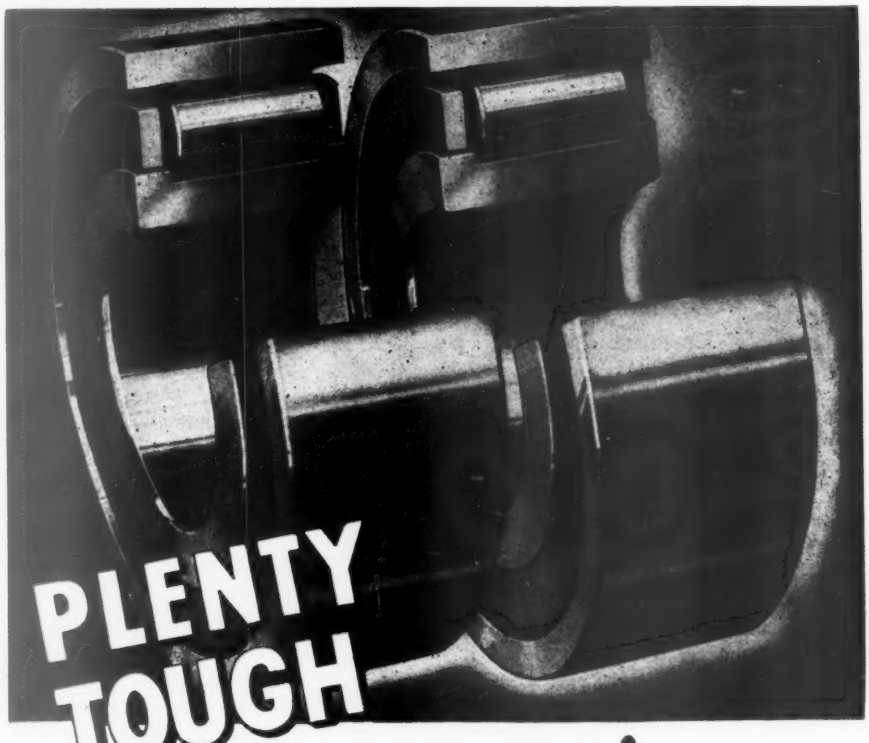
E. P. Trout

L. A. Little

Walter W. Trout, vice president and general manager, has been in charge of the company's Tulsa and Dallas offices and, in recent years, has relieved his father as general manager.

W. C. Trout will act in the capacity of president, a position he has held for many years. Trout, holding many patents important to the oil industry, will devote a great deal of his time in the future to research.

A. E. Cudlipp, newly elected board director, has been active in the company for the last 26 years, serving in various capacities having to do with purchasing, publicity, and sales promotion and in charge of the company's industrial supply division.



PLENTY TOUGH BUT... easy going

There is an adaptable, durable, reliable, easy-going AMERICAN RADIAL ROLLER BEARING for almost every heavy duty application where the load is radial. Because they are designed to exacting engineering standards ... are constantly inspected and precision tested for absolute accuracy ... AMERICAN RADIAL ROLLER BEARINGS render smooth, continuous service under the most rigorous operating conditions. Lower maintenance costs and increased performance-life of heavy machinery and equipment result.

AMERICAN RADIAL ROLLER BEARINGS are made in 5 styles, 4 S.A.E. series and 85 sizes. Special designs to order are also available. Consult our engineering department freely on all your roller bearing problems.

AMERICAN ROLLER BEARING CO.
PITTSBURGH PENNSYLVANIA

Pacific Coast Office: 1718 S. Flower St., Los Angeles, California

AMERICAN ROLLER BEARINGS HEAVY DUTY

AMERICAN
Heavy-Duty ROLLER BEARINGS

7 YEARS SERVICE

LINK-BELT 3≡BAR HYPER CHAIN *STILL GOING STRONG!*

7 Wildcat Holes . . . 1 Directional Well . . . 150 Round Trips on One Trouble Job . . . 65,558 Feet Total Drilling . . . Chain Trouble: *None* . . . But Read The User's Letter!

McDANIEL BROS.
DRILLING CONTRACTORS
DRAWER 276
MONT BELVIEU, TEXAS
Nov. 9, 1944

Link-Belt Company,
Southern Standard Bldg.,
Houston, Texas.

Gentlemen:

I'm sure you will be interested in the performance of your 3-Bar Hyper chain used on our IDECO Junior Giant draw works just returned to the manufacturer's shop for a general overhaul after more than seven years on the job. The chain, despite its seven years in service, was in good condition, and could have made considerable more footage.

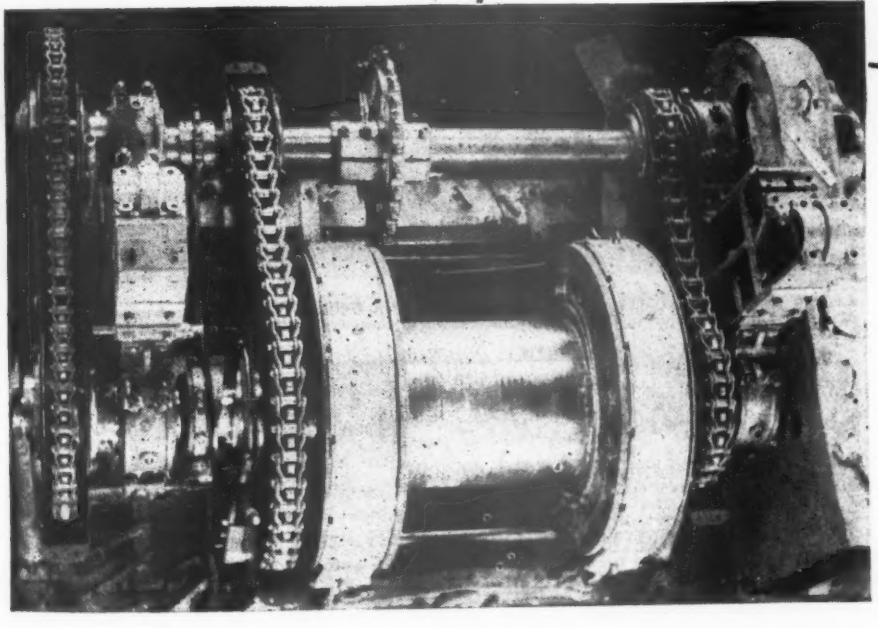
This draw works was bought in September, 1936 and drilled its first well at Bay City, Texas to 5,733 feet. It was moved to Barbers Hill, Texas and drilled a second well to 6,137 feet; then to Jeanerette, Louisiana and drilled an 8,000 foot well; then to Denham Springs, Louisiana and drilled a well to 7,656 feet; from which point it went to Woodland, Louisiana to drill two wells: one to 9,700 feet and one to 8,212 feet. From there it was moved to Davis Hill, Texas and drilled a well to 8,420 feet; and finally to Segno, Texas, where it drilled a well to 8,700 feet. On this last well we had considerable difficulty and were on the location about six months, during which time approximately 150 round trips were made.

All of the above wells, with the exception of the Barbers Hill location, were wildcats and I estimate that each well drilled was equivalent to far more than the actual footage involved. The Barbers Hill well was a directional job, and required lots of additional work over a normal hole.

The fact that Link-Belt's 3-Bar Hyper chain stood the gaff of this type and period of service, without replacements or trouble, is pretty good proof of the quality built into it.

Very truly yours,
McDaniel
MC DANIEL BROS.

JAM/dwm



Link-Belt is justly proud of this tribute, another well known rig owner pays to our heavy duty rotary chain. He is one of thousands in the oil country who knows from experience the value of Link-Belt's more than 68 years of chain building experience . . . who appreciates the results of continuous research to improve chain quality that saves time, money and trouble for the operator. His detailed record of facts reproduced here is further testimony to Link-Belt leadership in chain.

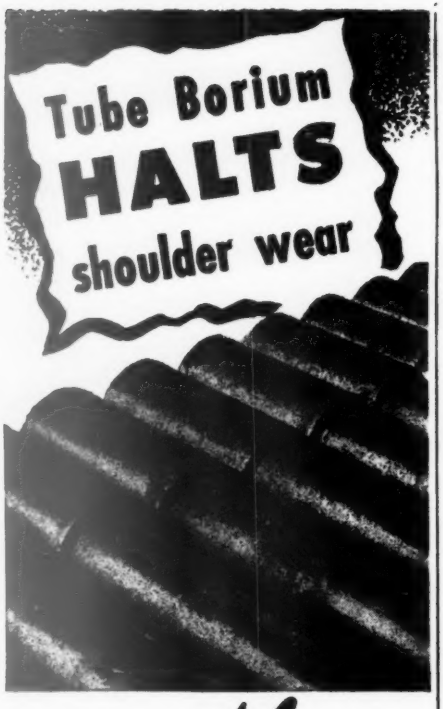
LINK-BELT CHAINS . . . a Type for Every OIL INDUSTRY SERVICE

LINK-BELT COMPANY

Indianapolis 6, Dallas 1, Houston 2,
Los Angeles 33, Kansas City 6, Mo.,
New York 7, Toronto 8.
Distributors in all fields.

Also manufacturers of silent chain drives, roller chains, roller and ball bearings, and other transmissions equipment, mud screens and cranes.

U777

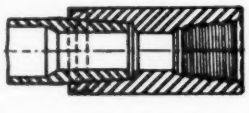


Doubles tool joint life

For fifteen years Tube Borium has been used on drilling bits to increase cutting speeds and drill more out-to-gauge hole. Now you can use this same alloy to greatly prolong the life of your tool joints!

An exceedingly small quantity of Tube Borium welded in a ring around the shoulder not only doubles tool joint life—even under the toughest operating conditions—but maintains over all joint strength and correct elevator contour. Applications are economically made on both new and resleeved joints.

APPLICATION: Accepted method of application is to under-cut new or resleeved joints at the shoulder to form a recess ⅛" deep by 1½" wide. The recess is then filled by welding in with ¾" Electric Tube Borium to form the wear resistant inlay.



Write for this special Stoody engineering bulletin describing in detail hard-facing procedures on tool joints—no obligation.

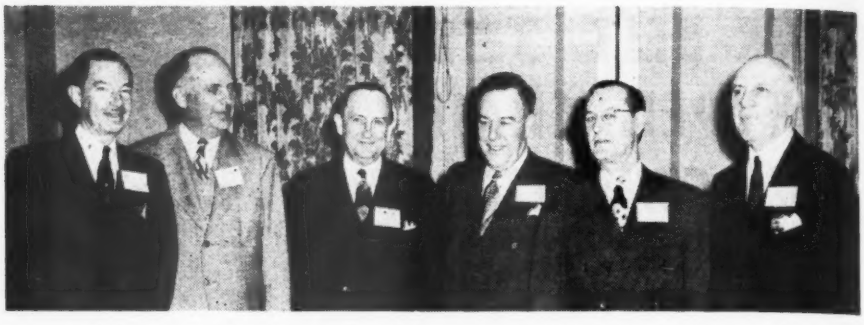
STOODY COMPANY
1142 WEST SLAUSON, WHITTIER, CALIF.

STOODY HARD-FACING ALLOYS
Retard wear... Save Repair

Bank pays tribute

The First National Bank in Dallas was host at an "appreciation" dinner February 15 to approximately 400 members of the oil fraternity in testimony to the magnificent part the petroleum industry has played in the war effort and in the development of Texas and the Southwest.

Vice President McElvaney was toastmaster and the principal speaker of the evening was William R. Boyd, Jr., of Washington, D. C., president of the Petroleum Industry War Council and of the American Petroleum Institute. Other speakers included Ralph Zook of Bradford, Pennsylvania, president of the Independent Petroleum Association of America; Maston Nixon of Corpus Christi, president of the Texas Mid-Continent Oil and Gas Association; Russell B. Brown of Washington, D. C., general counsel of the IPAA; Dr. E. DeGolyer, a director of the bank, who presented Boyd, and Chairman Nathan Adams and President E. L. Flippen of the bank.



Left to right: Eugene McElvaney, First National Bank, Dallas; Maston Nixon, Southern Minerals Corporation, Corpus Christi; W. R. Boyd, Jr., American Petroleum Institute, New York; Russell B. Brown, Independent Petroleum Association of America, Washington, D. C.; Ralph T. Zook, president, Independent Petroleum Association of America, and Edgar L. Flippen, First National Bank in Dallas.

Left to right: Nathan Adams, First National Bank in Dallas; W. C. Trout, Lufkin Foundry and Machine Company, Lufkin; Lloyd A. Little, Lufkin Foundry and Machine Company, Dallas.

Shafer officers

At the annual meeting of the stockholders of the Shafer Bearing Corporation held in Chicago, the following officers and directors were elected: Ray P. Tennes, president; J. F. Ditzell, executive vice-president and general manager; M. J. Tennes, Jr., vice president; A. H. Williams, vice president in charge of engineering; I. B. Lipson, secretary; A. L. Gray, assistant secretary and treasurer; and E. H. Ferguson, assistant treasurer. The following were elected directors of the corporation: Ray P. Tennes, J. F. Ditzell, W. P. Cagney, J. F. Griswold, and J. F. Tennes.

Since 1941 Shafer's entire production has been devoted exclusively to the production of anti-friction bearings for use in war equipment.

Meeting postponed

The board of directors of the Natural Gasoline Association of America at its recent meeting, voted to postpone indefinitely the 24th annual convention of the association, which was scheduled for April 11-13, in the Baker Hotel, Dallas, Texas. This move was made in compliance with the request of the Office of Defense Transportation that all trade groups aid in the overall transportation problem by cancelling meetings.

In lieu of the convention, a special board of directors meeting will be held to transact such annual business as is required and to consider matters of policy that may affect the industry throughout the year. No date for this small group meeting has been announced.

UOP vice president

Edwin F. Nelson, head of the engineering and development department of Universal Oil Products Company, was elected vice president at a recent meeting of the board of directors.

E. F. Nelson

Nelson, who is a graduate in chemical engineering of the University of Wisconsin, joined the Universal organization in 1926. Through his work as a field engineer, in the research laboratories and on the pilot plants at Riverside, in the patent and engineering departments, and as assistant to J. G. Alther, executive vice president, he learned the cracking art and technique and the operations of Universal and its licensees.

When the commercial development department was established in the early 30's, Nelson was placed at its head. In 1938 the engineering and development departments were combined under his leadership.

Director of engineering

The National Supply Company announces the appointment of J. R. Mahan as director of engineering for its plants at Toledo and Springfield, Ohio; Torrance, California; Houston, Texas, and Carnegie, Pennsylvania. From headquarters in Toledo Mahan will formulate and direct general engineering policies, coordinate engineering activities, and supervise the development and standardization of all manufactured products except tubular items.

J. R. Mahan

Mahan joined National's engineering staff in 1922 after completion of engineering courses at the University of Kansas and post graduate work at Massachusetts Institute of Technology. In 1935 he was appointed chief engineer of the Toledo plant and has served in that capacity to his present assignment.

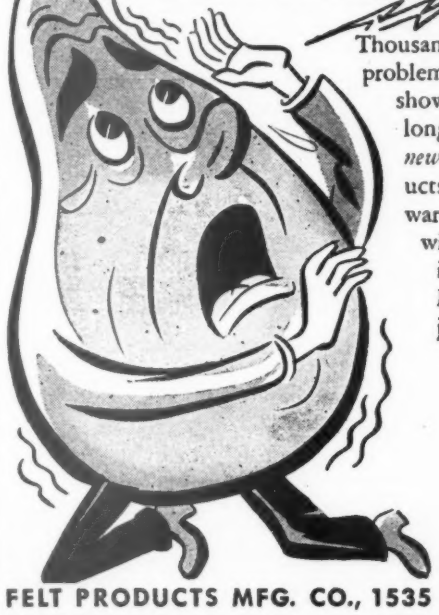
District sales manager

J. J. Walsh, who has been associated with the company for 22 years, has been appointed district sales manager for the New York district of the Page Steel and Wire Division of American Chain and Cable Company, Inc., with headquarters at 230 Park Avenue, New York.

BUY WAR BONDS

DOOM FOR THE LITTLE DRIP!

When you send for this FREE FOLIO of Fel-Pro Sealing Materials



Thousands of industries have solved their gasket problems by sending for Fel-Pro's FREE FOLIO showing a wide variety of more efficient and longer lasting sealing materials. You'll find *new* materials, too . . . improved sealing products developed and perfected through Fel-Pro's war work and research . . 52 actual samples, with scores of sealing suggestions . . . and if you don't find what you need, consult Fel-Pro engineers. They'll develop a product just right for your special gasket problems.

Write for your FREE FOLIO today!

SYNTHETIC RUBBER · PAPER · CORK · FELT · FIBRE · ASBESTOS
FEL-PRO GASKETS
packings • sealing materials

FELT PRODUCTS MFG. CO., 1535 Carroll Ave., Chicago 7, Illinois

WISCONSIN HEAVY-DUTY Air-Cooled ENGINES on the job PIPE LINE PUMPING

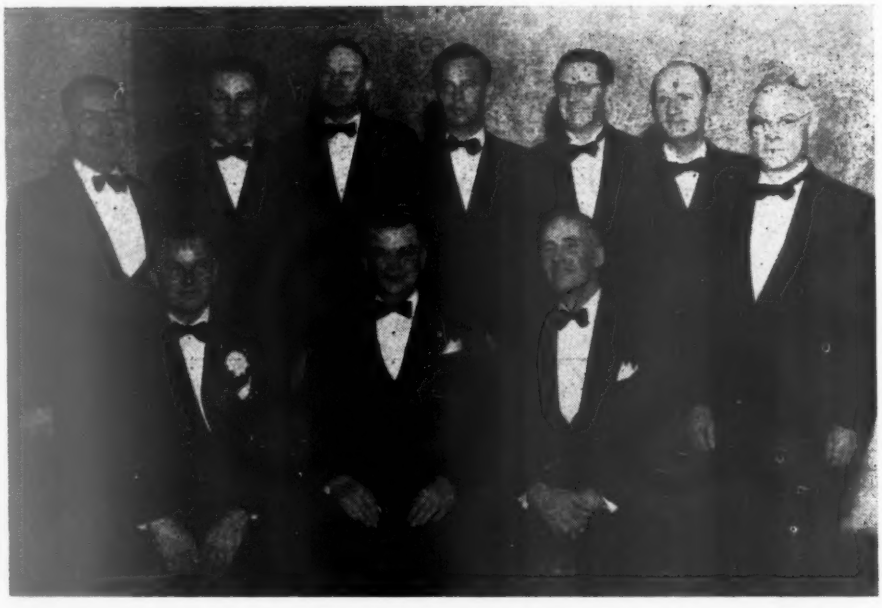
The Wisconsin engine-powered reciprocating pump pipe-line transportation unit shown in the above illustration was installed in 1937 and, at last reports, was continuing to give the Sinclair Prairie Pipe Line Company almost perfect service, in this operation, at Seminole, Okla.

No matter what type of equipment or operation you have that requires dependable engine power . . . you can't go wrong if you specify "Wisconsin Heavy-Duty Air-Cooled Engine".

WISCONSIN MOTOR Corporation
MILWAUKEE 14, WISCONSIN
World's Largest Builders of Heavy Duty Air Cooled Engines

WRITE TO HARLEY SALES CO.
510 Atlas Building, Tulsa, Oklahoma
M & M Building, Houston, Texas
Oil field distributors for Wisconsin Engines and all types of utility units.

Officers of Los Angeles Nomads



Pictured are the new officers of the Los Angeles chapter of Nomads. Left to right, seated: Roland E. Smith, regent; Elmer R. Smith, president, and Henry W. Pullman, regent. Standing: Custer Morrow, deputy sergeant-at-arms; Jim Robinson, secretary; C. M. Byron, assistant secretary; Waldo Moore, assistant treasurer; Hi Cassidy, sergeant-at-arms; Fred Tyler, treasurer, and Bill McGraw, vice president.

Levorsen to Stanford

A. E. Levorsen, independent research geologist of Tulsa, Oklahoma, and past president of the American Association of Petroleum Geologists, has been appointed professor and executive head of the department of geology at Stanford University, President Donald B. Tresidder has announced. He will arrive at Stanford at the beginning of the autumn quarter in September.

After graduation from the University of Minnesota in 1917, Levorsen served as geologist for several oil companies. Immediately before becoming an independent research geologist and consultant in 1936, he was chief geologist for the Tidewater Oil Company.

A member of the National Research Council, Levorsen also is a councillor of the Geological Society of America and the Society of Economic Geologists. For the last 7 years he has been chairman of the research committee of the American Association of Petroleum Geologists and was president of that group in 1935.

Levorsen is editor of *Possible Future Oil Provinces of the United States and Canada* and *Stratigraphic .Type Oil Fields*, in addition to numerous technical studies dealing with petroleum geology, structural geology, and stratigraphy.

During the last few years, he has been a visiting lecturer on geology at major universities throughout the United States.

Award to Peerless

To the pump industry's war record add a new Army-Navy "E" award for production excellence to Peerless Pump Division of Food Machinery Corporation. Peerless' Los Angeles plant has received its second award of an "E" star for 6 months more of production excellence.

Service engineers

Announcement was recently made by A. J. Kerr, general sales manager of Pittsburgh Equitable Meter Company-Merco Nordstrom Valve Company, of the addition of two service engineers to the firm's New York district office. These men, William H. Johnson and George L. Geuss, will handle the sale and service of Pemco and Merco products in sections of the territory under the jurisdiction of M. J. Harper, district manager. The New York office territory comprises most of that state and the state of New Jersey.

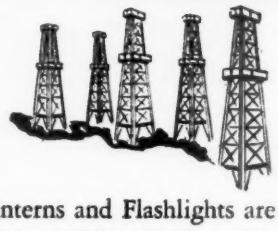
W. H. Johnson

G. L. Geuss

Johnson, a native of New York City, has been connected with the manufacture of water meters and water meter parts for the last 15 years.

Geuss has been with the company for several years, covering a part of New York State. In his new assignment, he will cover the same area as before, plus some new territory in the state.

HIROHITO *says "So Unhappy"*
when JUSTRITE'S *on the job*



● Justrite Safety Lanterns and Flashlights are just another "pain-in-the-neck" to the Axis. For they help protect men and equipment against the hazards of fire and light failure.

The New Justrite Handy-Safety Flashlight

A mighty midget flashlight of 1500 candlepower . . . 3 standard cells sealed in a plastic case that has all the famous Justrite safety features. It fits in the palm of your hand, on belt clip or stands alone. Equipped with high efficiency, higher voltage low drain bulbs that increase the light power and at the same time save on batteries. Here is an all-purpose flashlight for the oil industry that's . . . Justrite.

Model No. 17-S

See your Supply Companies for specifications. Catalog on request.

JUSTRITE MANUFACTURING COMPANY 2063 N. Southport Ave., Dept. G-2, Chicago 14, Ill.

BUY WAR BONDS

Heads N.Y. Office

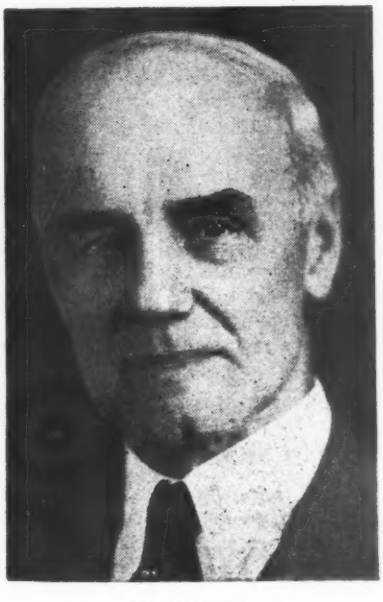
Gilbert H. Gaus has recently been appointed manager of the Gardner-Denver Company's New York branch office at 76 Ninth Avenue. He succeeds G. V. Leece, vice president, who has been placed in charge of the company's export division.

To his new position, Gaus brings a wealth of practical experience. For the last 7 years he has been with the Gardner-Denver New York office as sales engineer, handling all products manufactured by the company. Previous to joining the company in 1938, he had 18 years' experience in engineering and sales in the New York area, on pumps and other mechanical and electrical equipment for industrial plants, power plants, water works, and sewage plants.

Gaus studied mechanical and electrical engineering at the Massachusetts Institute of Technology and was graduated in 1917. He entered the army and during World War I was a first lieutenant in the Coast Artillery Corps. Since 1925, he has been a licensed professional engineer in the State of New York.

W. C. Norris passes

Funeral services for W. C. Norris, 83 years old, president and founder of W. C. Norris, Manufacturer, Inc., of Tulsa, and a pioneer manufacturer of oil field equipment, were held January 24 in



W. C. Norris

Washington, D. C. He died at his home there of a heart attack.

Norris was born in Glenn Falls, New York, on December 19, 1861. He started an oil field tool and equipment business in Tiona, Pennsylvania, before he was 21 years old. He moved to Tulsa in 1910 and founded his company, beginning with a crew of 10 men, and by 1943 nearly 900 persons were on the payroll. Branch stores are situation at Kilgore, Odessa, Houston, Texas, and Salem, Illinois, with a district office at Dallas, Texas, and an export office in New York City.

In recent years Norris lived in Washington, making frequent trips to Tulsa. The main plant at Tulsa and all branches were closed in his honor while funeral services were held in Washington.

Sales department changes

Three changes in the sales department of United States Steel's National Tube Company have been announced in Pittsburgh by J. E. Goble, vice president in charge of sales.

J. B. Graham becomes assistant to the vice president in charge of sales. W. J. McKee will be central areas sales manager and W. T. Miller is named assistant to general manager of sales. Graham and McKee have been assistant general managers of sales since 1936.

Graham began working for National Tube in 1905, became an oil field representative in 1917, and later was made superintendent of field work and inspection. He has specialized in pipe sales for the oil industry.

McKee started with the company in 1912 as an engineer. In 1931, he became manager of sales of the company's Tulsa, Oklahoma, office and later held the same position in New York.

Miller has held various sales positions since 1907.

National Tube offices in the Southwest are in Dallas, Houston, and Tulsa.

BECAUSE even the toughest pipe coating needs protection against soil stresses and earth loads, more than 50,000 miles of oil and gas pipelines throughout the world are wrapped with Johns-Manville Asbestos Felts.

Made from a mineral base, J-M Asbestos Felts provide a wrapping that insures lasting protection to coatings against distortion and abrasion. Their asbestos fibers, being inorganic and non-tubular, cannot support capillary action... are immune to rot or decay.

Today, pipe lines are coated and wrapped with Johns-Manville Asbestos Felts in the field... in a single, time-saving operation... with the J-M power-driven Coating and Wrapping machine, the result of more than 20 years of experience in solving application problems.

Full details may be had by writing Johns-Manville, 22 East 40th Street, New York 16, N. Y.

JM PRODUCTS **Johns-Manville *Asbestos* Pipeline Felts**

BUY WAR BONDS

Bumbaugh promoted

Promotion of Frank T. Bumbaugh as manager of sales, Alloy Division, has been announced at Pittsburgh, Pennsylvania, by Carnegie-Illinois Steel Corporation, U. S. Steel subsidiary. Bumbaugh succeeds the late Frank L. Gibbons, whose assistant he had been for the last 3 years.

A native of Monnessen, Pennsylvania, Bumbaugh began his employment in the Carnegie-Illinois Steel Corporation in 1926 at the Duquesne works, two years after his graduation from Lehigh University with a degree of metallurgical engineer. After service in Pittsburgh in the bar, semi-finished and alloy products division he was transferred to Chicago where he served in the Alloy Division of the corporation.

Heads Norvell-Wilder

Directors of the Norvell-Wilder Supply Company of Beaumont, Texas, at the annual meeting, elected Lip Norvell as president and general manager, succeeding E. W. Gildart. Gildart was elected a vice president.

Norvell has been associated with the company for 25 years, having been manager of the company's branch at Fort Worth for a number of years. He returned to Beaumont about 3 years ago and was serving as vice president and general manager until his recent promotion.

Other officers of the company re-elected at the meeting were Frank S. Carothers, vice president and manager of the company's Houston branch, and A. H. Schultz, secretary and treasurer.

Members of the board of directors are Mrs. Pansy Yount, J. H. Phelan, E. W. Gildart, M. T. Schlicher, R. E. Masterson, Norvell, Carothers, and Schultz.

Assistant sales manager

Hunt Tool Company announces the appointment of W. H. Smith as assistant sales manager. He has been stationed at Casper, Wyoming, where he represented Reed Roller Bit Company as division manager for the last 6 years. Smith has been a member of the Reed sales department since graduation from the University of Texas in 1934. In his new connection with Hunt he again serves under W. J. "Bill" Nutto who resigned as sales manager of Reed in 1944 to become vice president and sales manager of Hunt Tool Company.

W. H. Smith

Four time winner

For the fourth time the Sterling Engine Company, Buffalo, New York, manufacturer of gasoline and diesel engines, has raised a new Army-Navy "E" flag over its plant, this time with the third star affixed, signalizing a continuance of high production standards for war.

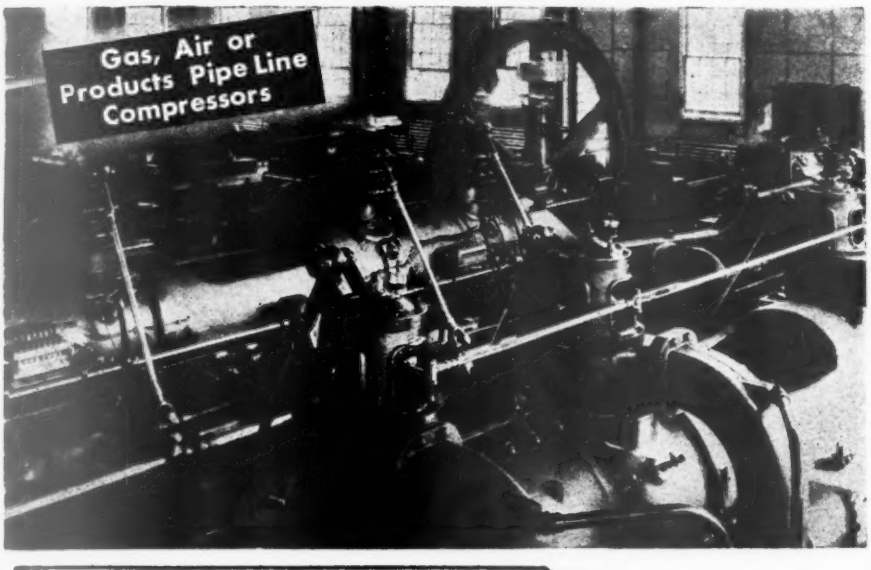
Announcement of this latest honor was made in a congratulatory letter by Admiral C. C. Block, U.S.N. (Ret) to Addison F. Vars, president of the Sterling company. The first award was made in April, 1943, and has been repeated at regular intervals.

General sales manager

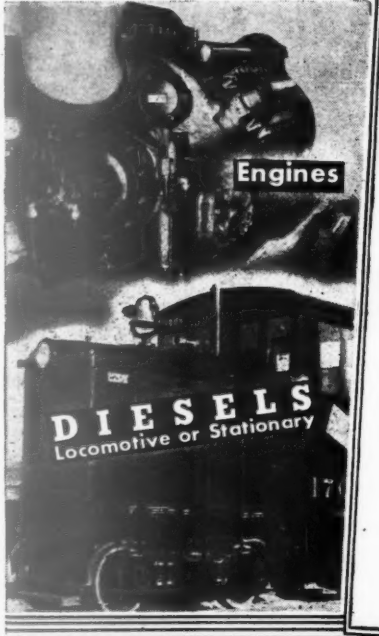
R. P. Tyler has been appointed general sales manager for Macwhyte Company, wire rope manufacturers, Kenosha, Wisconsin. He is widely known throughout industry, having been sales manager for A. Leschen and Sons Rope Company of St. Louis, and prior to 1940 in sales and engineering capacities with John A. Roebling's Sons Company, Trenton, New Jersey.

R. P. Tyler

H. E. Sawyer, formerly general sales manager as well as vice president and treasurer of Macwhyte Company, will continue as vice president and comptroller.



WATER PROBLEMS RESPOND TO



HAERING GLUCOSATES

FOR

CORROSION & SCALE CONTROL.

—o—

WRITE FOR

"H-O-H WATER STUDIES"

WE READ WATER

D. W. HAERING & CO., Inc.

GENERAL OFFICES:

205 West Wacker Drive, Chicago 6, Ill.

New officials

E. Souchon

A. J. Stoll

E. Souchon has been elected vice president in charge of operations and Andre J. Stoll secretary and treasurer of Schlumberger Surenco, S. A., Apartado 1608, Caracas, Venezuela, who operates the Schlumberger services in Venezuela. Colombia, Ecuador, Trinidad, Cuba, and Hispanola.

Heads Cummins exports

J. H. Patterson has been appointed manager of the Cummins Diesel Export Corporation, subsidiary of the Cummins Engine Company, Inc., Columbus, Indiana, manufacturers of heavy-duty diesels for automotive, marine, and industrial service.

J. H. Patterson

Offices of the export corporation are at 6303 Chrysler Building, New York 17, New York.

Patterson has specialized in the development of service and sales organizations for the last 20 years. Prior to his appointment as Cummins export manager, he was division manager of the National Refining Co.

The Cummins Engine Company manufactures high speed and medium speed heavy-duty diesels in the 50-275 hp. range for automotive, industrial, nad marine applications.

With many engines already in service in Latin American and other countries, Cummins anticipates a much greater volume of export sales after the war because of the increasing industrialization of Central and South America.

Awarded fourth star

The Ohio Injector Company of Wadsworth, Ohio, manufacturers of OIC steel, bronze, and iron valves, has been awarded its fourth star for continued high achievement in the production of war equipment. Word to this effect has been received by Wayne Young, president of the company, from Admiral C. C. Bloch, USN, Chairman of the Navy Board for Production Awards.

The award of the Army-Navy "E" was made to OIC in July, 1942, and the presentation was made at Wadsworth by Captain Ross Pelton Schlabach, USN. John B. Kennedy, noted radio commentator, served as master of ceremonies. The presentation was one of the first in the country to be carried on a coast-to-coast radio network.

Buys two concerns

American Engineering Company has concluded negotiations for the acquisition of the entire outstanding stock of Cochrane Corporation, Philadelphia, Pennsylvania, and Faraday Electric Corporation, Adrian, Michigan. Faraday manufactures electric signalling devices and specialized electrical household appliances and Cochrane produces various products used in the industrial and power plant equipment fields.

According to the announcement, both companies will be operated as subsidiaries of American Engineering Company.

By acquisition of the Cochrane and Faraday units American Engineering Company will participate in more diversified engineering, research, and manufacturing activities than heretofore, and it is expected that numerous advantages for the three companies will be achieved.

Percy S. Lyon will continue to serve as president and director of the Cochrane Corporation, and will become a director of American Engineering Company. E. I. Kleinman, J. M. Doroshaw, J. S. Ackerman, Allison L. Bayles, and Thurlow E. McBride, all officers of American Engineering Company, have been elected directors of Cochrane Corp.

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FOR CASING FISHING JOBS Spang offers a variety of tools including Casing Cutter; Casing Splitter; Out of Collar Ripper (F515); Swage; Bell Socket; Bull Dog Spear; and Trip Spear (F501).
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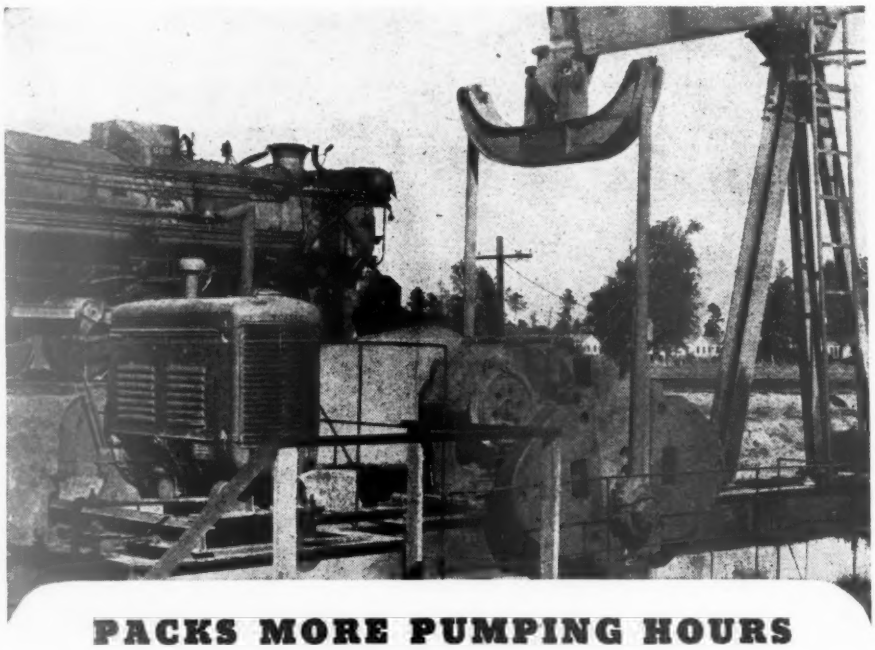
Plan meeting

Sanction has been given by ODT and plans are almost complete for the wartime conference of the API Pacific Coast District Division of Production, which is scheduled for the Biltmore Hotel, Los Angeles, on March 29. Under the chairmanship of George Suman, Basil P. Kantzer, in charge of the program, has arranged for an interesting group of speakers for the morning and afternoon sessions. It is expected that William Boyd, Jr., president of the American Petroleum Institute, and Ralph K. Davies, deputy administrator of the Petroleum Administration for War, will be the principal speakers at the banquet in the evening.

Speakers and subjects, so far tentatively scheduled for the technical sessions are as follows: "California's New World Record Hole," by Omar A. Cavins, Standard Oil Company. "Oil Well Casing Tests," by F. R. Schmeider and R. F. Kettenburg, Shell Oil Company. "Reservoir Fluid Flow Research," by Norris Johnston, General Petroleum Corporation, and N. Van Wingan, Richfield Oil Corporation. "Field Testing of Drilling Fluids," by Vernon B. Zacker, Tide Water Associated. "Viscosity Tests on Heavy Crudes," by Richard Zinzer, Union Oil Company. "Gas Lift Through Small Tubing," by A. T. Tutschulte, Tide Water Associated. Other papers are being assigned.



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WHATEVER you mean by Endurance . . . hours without shutdown, months without minor maintenance, or years before major overhaul . . . you can look for a lot of it in Case Oilfield Engines. Their record reveals many non-stop runs of months and sometimes years.

Such endurance comes not only from abundance of strong points, but more especially from absence of weak points. It comes not only from a habit of building engines a bit better than need be, but from a hundred years' experience in building machines sturdy and simple. It comes, too, from the fact that Case Oilfield Engines take so little routine attendance that there is less likelihood of slighting it.

If you have Case Engines now, make sure they get the little care they call for regularly, so that you will get all those extra pumping hours. If you need more pumping power, ask your Case distributor about the possibility of supplying you. J. I. Case Co., Racine, Wis.

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Southwest Machinery Co., 1900 Linwood Blvd., Oklahoma City, Okla.
Wm. K. Holt Machinery Co., San Antonio, Texas

CASE KEEP ON BUYING WAR BONDS

To capitol staff

Appointment of Walter F. Myers to the staff of the Washington office of The Cooper-Bessemer Corporation is announced by Stanley E. Johnson, general sales manager.

W. F. Myers

Myers brings to the company a broad experience in the equipment and diesel field, having served during the last 25 years as sales engineer, construction engineer, and consulting engineer for public and private corporations, including the Fairbanks Morse Company, the Federal Power Commission, and the United States Maritime Commission.

Myers will assist Charles G. Cooper, director of the Cooper-Bessemer Washington office in the handling and supervision of government contracts and sales and service in the Southern Atlantic States.

New district manager

The Continental Supply Company announces the resignation of V. E. Sheffer, assistant district manager, Wichita, Kansas, effective January 31. Sheffer had been an employe of Continental approximately 22 years. He is entering the drilling contracting business and will operate in Kansas as the Sheffer Drilling Company.

V. E. Sheffer

F. B. Collett

F. B. Collett, former city representative of Continental at Oklahoma City, Oklahoma, has been transferred to Wichita, Kansas, in the capacity of manager and will be in charge of the Wichita office.

Washington office

Washington offices of the Independent Natural Gas Association of America have been opened, E. Buddrus, president, announces. The new offices, Suite 305 at 1700 I Street N. W., will operate under the direction of John A. Ferguson, executive director, recently appointed.

The association will continue to maintain its Mid-Continent offices in Oklahoma City, Oklahoma.

Training course

The A. & M. College of Texas in cooperation with the U. S. Office of Education is giving a tuition free 48-hr. war training course entitled "The Engineering and Administration of Oil Lands," which began February 8 at the Crozier Technical High School, Dallas, Texas.

The class is open to high school graduates employed in the oil industry or some allied war industry where training in land mapping, leasing, and title work would be useful. Lectures and discussions on 16 phases of the subject are conducted by outstanding oil men of Dallas and Fort Worth.

New western manager

Promotion of E. M. Ferguson, assistant western manager, to western manager has been announced by R. G. LeTourneau, Inc., Peoria, Illinois, and Stockton, California.

Ferguson, with LeTourneau since January, 1939, originally served as district representative in the Los Angeles area until 1943. At that time he was appointed assistant western manager.

California sales manager

Abegg & Reinhold Company, Los Angeles, California, has announced the appointment of H. C. (Whitey) Clark as California sales manager. Clark has been with the company since 1942, having served in the sales and service departments in the Los Angeles Basin and Coastal District during that time. He has been in the oil equipment business for the last 10 years having first worked for Crum-Brainard Corporation from 1934 to 1936. He then went with Globe Oil Tools Company for a period of 3 years. For one year after that he was manager of the Bakersfield district for Universal Engineering Company and then California sales manager and general overseer of sales for that company in the Mid-Continent and Canada.

Thomas O'Donnell passes

Thomas A. O'Donnell died in Los Angeles, California, February 20. He was born 73 years ago (1872) in the Pennsylvania oil country, just 13 years after Colonel E. L. Drake had discovered oil at Titusville.

In 1893 O'Donnell went to California. There he began as a lease worker, later becoming a contractor, and then entered the producing branch of the oil industry. He was president of the American Petroleum Company, a Doheny concern, for many years, and was active in developing the Coalinga, Midway-Sunset, and Kern River fields of California, including the "Star" group of producing companies.

O'Donnell helped organize the Independent Producers' Agency of California.

During World War I he was in charge of the production division of the oil division of the U. S. Fuel Administration —Mark L. Requa headed the oil division.

O'Donnell was first president of the American Petroleum Institute, from March 26, 1919, to December 11, 1924, and has long been known as one of the "grand old men" of the industry.

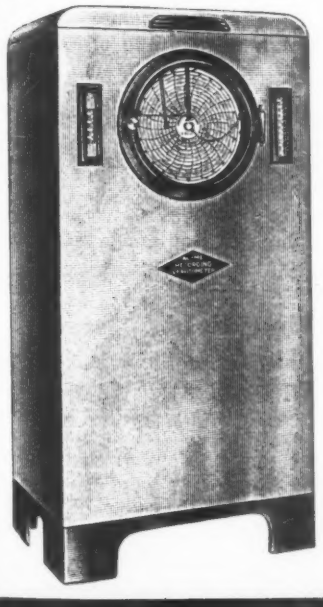
On December 11, 1924, at the fifth annual meeting of the Institute in Fort Worth, Texas (last time he presided as president) O'Donnell gave it as his opinion that the oil reserves of the U. S. would last 10 times 10 years, and that, when present methods of oil production became insufficient, we would have the Rocky Mountains to fall back on—with more oil buried in the shales than the country ever produced from its wells.

Worker's ideas pay

Production suggestions from employes, many of which accelerated the war program, netted General Electric workers $232,735 in awards during 1944, according to company tabulations recently released. The total payment was for 19,488 ideas adopted by the suggestion committee, slightly fewer than the all-time high of a year ago but 22 per cent more than those adopted in 1943.

Some of the suggestions incorporated into the company's production program aided the war effort by showing how to save critical materials or how to reduce the time required to complete a job. Others eliminated safety hazards, whereas still others simplified work operations.

for PIPE LINE SPECIALTIES



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Accurately records the changing gravity of gas and automatically corrects for variation in temperature and barometric pressure.

Elimination of complicated rotating parts from the design permits simple, sturdy construction that requires only a minimum of maintenance to keep the instrument functioning.

Charts are changed without exposing the main part of the instrument. A large glass door gives complete visibility to the record while the instrument is operating.

Write for New Equipment Bulletin No. 30

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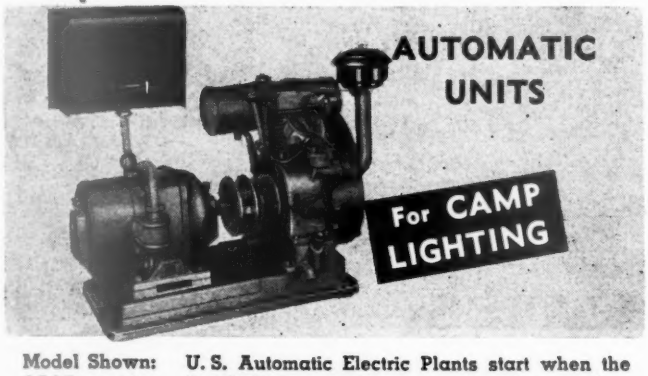
Model Shown: 6.25 KVA. 4-cylinder, gasoline. Water cooled. Push-button starter.

U. S. Electric Plants are engineered by men familiar with oil-field operating problems . . . and backed by over 50 years of manufacturing experience. Operating panel and instruments under weather-proof housing. Compact. Skids make handling easy. Complete line includes Gasoline units from 500 watts to 75 KW; Diesel units from 2 to 75 KW. AC and DC.



Model Shown: 1500 watts, 115 volts, AC. Automatic control. Single cylinder, air-cooled engine.

U. S. Automatic Electric Plants start when the first light is turned on . . . stop when the last light is turned off. Manual control units also available. Can be supplied for operation on natural gas. Simple, trouble-free design and rugged construction have made these units famous for reliability. 800 and 1500 watt models are the most popular for camp lighting.

Unit Shown: 600 watts, DC.

Wherever a breakdown occurs, get things going again in a hurry . . . no need to work in the dark if this compact 67-pound electric plant is kept handy! Other Portable units up to 15 KW. Write for literature.

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C. A. McDade Co., 6526 Hamilton Ave., Pittsburgh 6, Penn.
Midland Implement Co., Box 2113, Billings, Mont. and Great Falls.

U.S. ELECTRIC PLANTS
GASOLINE • DIESEL

Book Reviews

▸ **Glossary of Foreign Welding Terms,** *compiled by M. A. Cordovi. Published by American Welding Society, 33 West 39th Street, New York, N. Y. Pages, 16. Price, 50c.*

Contractors, students, and others who have occasion to consult welding drawings or specifications using German, French, Russian or Spanish will welcome this new glossary of foreign welding terms. Many of the terms included in the 16-page paper-covered pamphlet have been derived from foreign technical literature and are not found in any standard or technical dictionaries.

▸ **Chamber's Technical Dictionary,** *edited by C. F. Tweney and L. E. C. Hughes. Published by The MacMillan Company, New York, N. Y. Pages, 975. Price, $6.*

The 1944 revised version of Chamber's Technical Dictionary comes as a welcome aid to both students and professions engaged in the fields of science and technology. It is a full and representative cross-section of the latest scientific terms brought out in a new and up-to-date edition, including a 24-page supplement with nearly a thousand new definitions.

The articles on vitamins have been revised in keeping with latest discoveries and improvements; and the sulphonamide drugs, the use of which has in recent years revolutionized certain branches of medical treatment, is described at length. Compiled by a group of thirty specialists in various fields, this book will prove indispensible to persons in any branches of pure and applied science, medicine, the chief manufacturing industries, engineering, construction, aeronautics, the mechanical trades and many other industries. It gives all definitions in terms of current knowledge and in a clear concise manner.

▸ **Audels Pumps, Hydraulics, Air Compressors,** *by Frank C. Graham. Published by Theo Audel and Company, 49 West 23rd St., New York, N. Y. Pages, 1610.*

Really three books bound into one, Audels newest publication deals in minute detail with the subjects of pumps, hydraulics, and air compressors. Purpose of the book is to supply information from numerous authorities on the subjects discussed. Considerable space is devoted to the practical side of installation, operation, maintenance and repair. Assisting the author in collecting and arranging the material was a group of experts in the various fields. Information was also secured from numerous manufacturing companies.

The author has also introduced a large number of elementary and skeleton diagrams to explain basic principles, construction being shown by photographs of the latest designs brought out by leading manufacturers. The book is a practical guide for engineers, mechanics, and operators, covering theory, construction, and operation of modern pumps, hydraulic machinery, and air compressors and blowers.

Expands in construction field

Worthington Pump and Machinery Corporation becomes one of the nation's largest manufacturers of construction equipment with the acquisition of the Ransome Machinery Company line of concrete machinery, according to an official announcement at the January meeting of Associated Equipment Distributors.

The announcement was in the form of a handsomely illustrated 48-page presentation entitled "A Preview," which displayed not only the products in the present combined lines, but several new types of equipment under development to be ready for production after the war.

C. F. Oechsle, Worthington's assistant vice president, has been placed in charge of the Worthington-Ransome construction equipment sales organization, with headquarters at Holyoke, Massachusetts. He will be assisted by W. F. Lockhardt, sales manager of Ransome Machinery Company at Dunellen, New Jersey, and W. J. Fleming, field sales manager, Holyoke, Massachusetts.

Five regional offices, located in New York, Washington, D. C., Cleveland, Chicago, and San Francisco, will afford nation-wide service to the construction industry.

Joins Dresser group

Negotiations have been completed and approved by the stockholders of the Day and Night Manufacturing Company, Monrovia, California, for the affiliation of that company with Dresser Industries, Inc.

Dresser Industries, composed of a group of companies joined together by common ownership, serves chiefly the gas and oil industries, manufacturing derricks, gas holders, tanks, pumping machinery, compressors, etc.

In the gas appliance field, the Bryant Heater Company of Cleveland, Ohio, has been a member company of Dresser since 1933. The Payne Furnace and Supply Company of Beverly Hills, California, also a recent affiliate, and the Day and Night Manufacturing Company will materially broaden the activities of the corporation in the gas appliance business.

The Day and Night Manufacturing Company has been in business in Monrovia since 1909, and has become one of the country's leading manufacturers of gas water heaters, gas space heating appliances, and water coolers.

Heath to Climax Moly

R. L. Heath recently joined the Climax Molybdenum Company in the capacity of metallurgical engineer. His headquarters at present are in St. Louis, Missouri.

R. L. Heath

Before going with Climax he was chief metallurgist of the Allison Division of General Motors Corporation at Indianapolis, Indiana. While there he served on several SAE committees dealing with aircraft engine materials and packaging.

Heath was also active in the American Society for Metals, having been chairman of the Indianapolis chapter, and chairman of the constitution and by-laws committee in 1940-41.

Westinghouse appointments

The appointment of Ernest P. Schroeder as manager of the foreign engineering department of the Westinghouse Electric and Manufacturing Company and the appointment of John T. Mathews as assistant manager have been announced by John W. White, president and general manager of the Westinghouse Electric International Company, and C. A. Powel, manager of headquarters engineering of Westinghouse.

Schroeder, who will retain his duties as resident representative of the International company, succeeds D. I. Vinogradoff, who was transferred to the International company on special assignment.

Schroeder, who was born in South Africa, received his schooling there and in 1906 received an electrical engineering degree from the Polytechnikum Mittweida in Germany. He was affiliated with Siemens in Germany and South Africa from 1906 to 1915, and was in charge of training South African troops at Johannesburg in 1915.

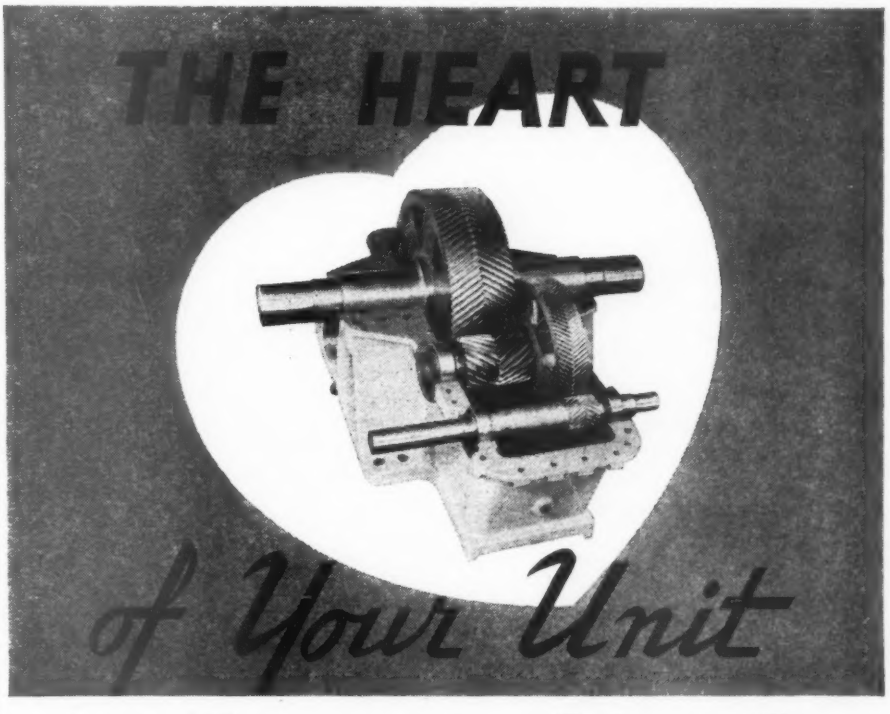
He came to the United States in 1916 and the following year joined Westinghouse and with the exception of one and a half years that he served with the Public Service Corporation of New Jersey, and one and a half years with one of the Westinghouse associated companies in Europe, has been employed by Westinghouse since that time.

Mathews, formerly engineering representative of the International Company in Argentina, was born in St. John, New Brunswick, Canada, and received his engineering degree in 1927 from the University of British Columbia.

He joined Westinghouse in 1927 and was assigned to engineering development work until 1934 when he joined the foreign engineering department as liaison engineer in France and Germany. Since 1940 he has been in England and Argentina for the International company.

New store

Bethlehem Supply Company has opened a new store at McAllen, Texas. Personnel includes W. H. Abele, store manager and field representative, and M. R. Kennedy, field service representative. This store is under the general supervision of J. P. Branch, district manager, Corpus Christi, Texas.



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"UNITED" Pumpers are given the advantage of 50 years successful manufacturing experience in the D. O. JAMES Herringbone, Continuous Tooth Gear transmission. United's entire pumping unit is characterized by assured long-lived service built into every part, component and assembly of this rugged, economical pumper.

These features D. O. JAMES products have proved in many fields:

BEARINGS: Large high grade bronze bearings on crankshaft—all other shafts equipped with Hyatt Hy-load bearings.

MATERIALS: Top quality steels—semi-steel housing; alloy heat-treated shafting; high tensile steel bolts.

GEARS: Continuous tooth Herringbone; heat-treated and lapped for minimum back-lash.

PERFORMANCE: No side thrust, avoidable deflection or distortion; uniform load across gear faces due to balancing thrust of opposing helices; durability first and lasting.

YES, SIR! WE CAN MAKE IMMEDIATE DELIVERIES FROM STOCK!

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United SUPPLY AND MANUFACTURING COMPANY

UNITED SUPPLY AND *Manufacturing* COMPANY

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Frank Hadley dies

Frank Leslie Hadley, vice president in charge of operations of Susquehanna Pipe Line Company, Philadelphia, Pennsylvania, died February 27 from a heart attack. He is survived by his widow, Lillie Limle Hadley, and a son, Raymond Frank Hadley.

Frank Hadley

Born near Ellicottsville, New York, February 28, 1880, Hadley enjoyed a long and productive career in the oil industry. He served as superintendent of the Peoples Natural Gas Company, Pittsburgh, Pennsylvania, from 1902-18; was vice president of the National Exploration Company, New York City, 1920-21; president and director of the Commonwealth Petroleum Corporation, New York City, 1919-21; president of Eddystone Oil Corporation, New York City; president, Western Union Oil Company, and Columbia Oil Producing Company, Los Angeles, California, 1920-22; vice president in charge of operations Union Oil Company of Delaware, New York City, 1922-1924; president National Petroleum Corporation, West Virginia, 1923-24; engineer, Attleboro Gaslight Company, Attleboro, Massachusetts, 1926-28; engineer for the Taunton Gaslight Company, Taunton, Massachusetts, 1924-30; general superintendent, Sun Pipe Line Company, Philadelphia, 1930-38; vice president and director, since 1938, Sun Pipe Line Company; vice president in charge of operations and director of the Susquehanna Pipe Line Company, Philadelphia, Middlesex Pipe Line Company, Trenton, New Jersey, Sun Pipe Line, Inc., Syracuse, New York, and The Sun Oil Line Company, Ohio, 1938 to the present.

Proudfit heads Creole

Arthur T. Proudfit has been elected president of the Creole Petroleum Corporation. He has been a vice president and general manager of the company's Venezuelan operations and will continue as general manager with his office in Caracas. He succeeds C. H. Lieb who died on December 30, 1944.

Horry F. Prioleau was elected executive vice president and becomes Creole's chief executive officer in New York. Prioleau has been a vice president and is a director.

Creole produces oil from extensive concessions in Venezuela and also has two refineries there. Formerly a holding company, it absorbed the properties of Standard Oil Company of Venezuela and bought the Venzuelan properties of Lago Petroleum Corporation in August, 1943, thus becoming a direct operating organization. It is an affiliate of Standard Oil Company (New Jersey).

The two new officers have both had more than 20 years' experience in the petrolum industry, largly in foreign operations. Proudfit started in 1919 as a drilling tool dresser for Huasteca Petroleum Company in its Tampico, Mexico, fields. Prioleau started work as a laboratory assistant in the Charleston, South Carolina, refinery of the Standard Oil Company of New Jersey in 1921.

Awarded white star

The Moorlane Company of Tulsa has been awarded a white star for its Army-Navy "E" flag for continuous meritorious production of war equipment, according to W. D. Moorer, president, who received word from Robert P. Patterson, under secretary of war.

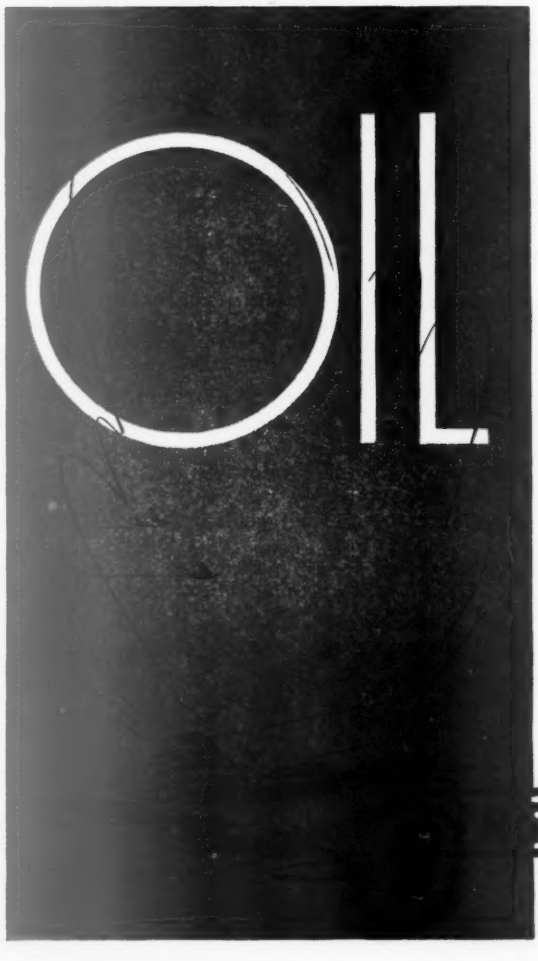
Moorlane received its "E" flag on September 8, 1944, primarily for the production of equipment used in connection with portable pipe line pumping stations.

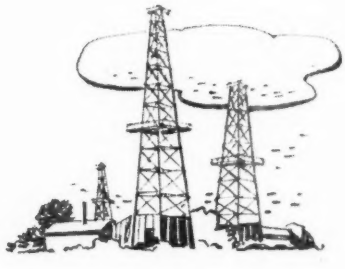
Elected a director

John Howard Collier, president of the Crane Co., Chicago, Illinois, was elected a director of the Allis-Chalmers Manufacturing Company, it has been announced by Walter Geist, Allis-Chalmers president, following a meeting of the board of directors.

Bethlehem acquires firms

Bethlehem Steel Company, New York City, has acquired the stock of the Petroleum Equipment Company and Petroleum Equipment International, according to an announcement by E. G.





MARCHES ON . . .

In the forefront of the war's dramatization of industry stands Oil . . . making an essential contribution to a global war.

It has been the privilege of this bank, through peace as well as war, to serve the oil industry.

We look forward to broadening, more than ever before, the scope of our service to oil men everywhere.

1st NATIONAL BANK IN DALLAS

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

1st NATIONAL

Grace, president of Bethlehem. Both are California concerns and will continue in business with general offices at 2800 South Alameda Street, Vernon, California, with the following executive organization: H. H. Fuller, vice president; G. W. Schweinhard, vice president and general manager, and R. Somers, assistant treasurer and assistant secretary.

Petroleum Equipment International will continue to maintain its San Francisco office in the Crocker First National Bank Building.

To petroleum committee

David Proctor, secretary and assistant general counsel for the Gulf Oil Corporation, Pittsburgh, has been appointed a member of the American Petroleum Industries Committee, it is announced by President W. R. Boyd, Jr., of the American Petroleum Institute.

Proctor was born in Cuero, Texas. After being graduated by the Tome Preparatory School, Port Deposit, Maryland, he entered the University of Texas, and was graduated with an LL.B degree in 1915. With his brother, Venable Bland Proctor, Jr., he practiced law in Victoria, Texas, until the entry of the United States into World War I. Rejected for active service because of underweight, he was offered, and accepted, the position of special agent for the Bureau of Investigation, Department of Justice, and acted a year in that capacity. Later he was accepted in the Intelligence Department of the U. S. Army, serving until the end of the war.

In 1919 Proctor resumed his law practice in Victoria, but in a few months joined the legal staff of the Gulf in Fort Worth. In 1937 he was transferred to Pittsburgh, and was elected secretary of the Gulf Oil Corporation and its domestic subsidiary companies. He still serves in that capacity. On January 1, 1943, he was appointed assistant general counsel of the corporation.

Re-equip department

Young Radiator Company, Racine, Wisconsin, designers and manufacturers of heat transfer products for heating, cooling and air conditioning, announces the re-equipping of their engineering department.

D. W. Christensen, chief draftsman, explained the new equipment.

"We have recently installed in our engineering department a new white print machine, which is Ozalid dry process. This is an Ozalid Type "B," the largest machine made for the manufacture and development of white prints. We have a printing speed on this machine up to 21 ft. per min. It is equipped with a powerful quartz light that makes this printing and developing speed possible. The average size drawing can be turned out ready for delivery in 30 seconds when the machine is in operation.

"We have also installed a new dark room with a photocopy machine, complete with a continuous rotor drum drier and special acid resistant washing tanks, and with this machine we are able to make photostatic copies of letters, drawings, etc. On this machine, we are also able to reproduce our original tracings on to a piece of vellum, giving us more than one tracing, if so desired.

"We have also installed in the engineering department new Hamilton Auto-Shift tables. This table, by pressing a lever at the base of the table, can be lowered to any desired height from a standing position to a very low sitting position of the draftsman. These tables also can be tilted with the top perfectly vertical and also perfectly horizontal. Any degree of tilting can be accomplished by a mere turning of a lever.

"Our new drawing boards are also equipped with parallel straight edges and are counterweighted so they will be held in any position, regardless of the angle of the board.

Also installed is a Vari-Typer machine, which is a large-type typewriter, capable of typewriting on the largest drawings, saving space on the drawing and eliminating the drafting time for printing. This machine is also used on bill of materials, which are written out in long hand and turned over to the stenographer who operates the machine. Being typewritten, more legible copy and better prints result and considerable drafting time is saved."

The addition of this new equipment will permit Young engineers to give more efficient service in the solving of their customer's heat transfer problems, company officials state.

DEPENDABLE

AS THE NAME THEY BEAR

AMERICAN
RADIAL
ROLLER BEARINGS

Engineered specifically for extra heavy duty applications where the load is *radial*, AMERICAN RADIAL ROLLER BEARINGS function smoothly and dependably under the most exacting service conditions. Specialized construction, flawless materials and precision manufacturing, set them apart as *the most dependable bearings yet designed* for radial loads where strains are greater . . . where toughness, super-strength and smooth, continuous, trouble-free performance are absolute requisites. AMERICAN RADIAL ROLLER BEARINGS are made in 5 styles, 4 S.A.E. series and 85 sizes. Special designs to order are also available. Write for complete data or send us your requirements for analysis and recommendations.

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AMERICAN
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For QUICK, ACCURATE TESTS
Use CURTIN CENTRIFUGES

No. 3420 15 c.c. machine . . . . Cranks and heads interchangeable with 100 c.c. machines.

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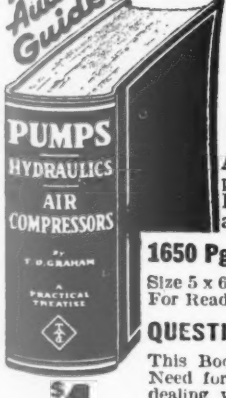

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New firm

Announcement has been made of the formation of The Hayes-Condit Company, 624 South Cheyenne, Tulsa, Oklahoma, headed by M. A. Hayes and D. J. Condit. The firm will serve as manufacturer's representatives in the Mid-Continent area and will provide engineering recommendations, sales, and servicing for a number of well known equipment lines in the production, refining, and process branches of the petroleum industry.

M. A. Hayes has been identified in the southwest territory for more than 20 years in construction and engineering work for refinery installations. D. J. Condit, a chemical engineer from the University of Missouri, has had wide experience in the Mid-Continent in instrumentation, control, and processing work.

G. H. Mettam dies

George H. Mettam, director and assistant general manager of manufacturing operations of Standard Oil Company of New Jersey, died recently of a heart ailment. He was 55. He had been associated with the company's refinery operations in New Jersey for 36 years.

In May, 1943, Mettam was granted leave of absence by Standard to serve 9 months with the Petroleum Administration for War in charge of refining for District 1 (East Coast). He resumed his position with the company in January, 1944.

A native of Bayonne, New Jersey, he attended schools there and later attended New York University. He was first employed by the company in the construction of its Bayway refinery in 1907.

In 1926, he was appointed mechanical superintendent of the Bayonne refinery, and the following year became superintendent of the mechanical department. He became assistant general manager of manufacturing operations in June, 1940, and was elected a director of the company in March, 1941.

Secondary recovery

A graduate-rank course in petroleum engineering on the subject of secondary recovery of petroleum is being offered, in Dallas, Texas, by the extension division of the University of Texas. It began on February 20. Dr. George H. Fancher, professor of petroleum engineering, held the first meeting at the Lone Star Gas Company building at 6 p.m.

Classes meet 3 hours a week for approximately 14 weeks. The course may be audited with approval of the instructor or may be taken for 3 hours of graduate credit by those having the prerequisites.

The same course was taught by Dr. Fancher in Houston last year. It covers the fundamentals of gas injection, water flooding, mining, and other means of recovering much of the petroleum that remains in the oil field reservoirs when customary methods of production have reached the economic limit.

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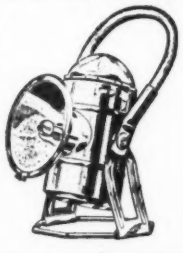

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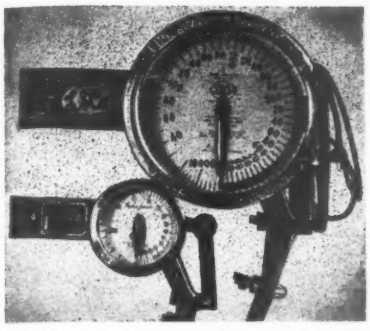

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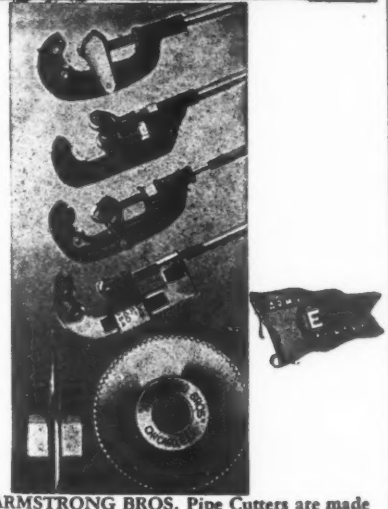

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General manager sales

Alton Parker Hall has been appointed general manager of sales of American Chain and Cable Company, Inc., with headquarters at 230 Park Avenue, New York, New York. Hall joined the company about a year ago as assistant general manager of sales after having been with Bethlehem Steel Company for 22 years.

Born in Kingston, New York, he was graduated from the Kent School in 1918, and from Princeton University in 1922. During World War I, he served in the army and became an officer in the Field Artillery Reserve Corps. He is well known in the metal and allied industries.

Changes address

Hill and Knowlton, public relations counsel, New York and Cleveland, has moved its Cleveland office from 1454 Guildhall Building to 323 Republic Building.

Both the Republic Building and the Guildhall Building are in the Cleveland Terminal Group and are, in fact, under the same roof. The zone number, therefore, remains the same—Cleveland 15.

The move was necessary to provide more adequate working quarters for the firm's enlarged Cleveland staff.

Buys Southern Lead

Announcement of Eagle-Picher's acquisition of the production and distribution facilities of Southern Lead Company of Dallas, Texas, effective March 1, was made in Cincinnati by J. M. Bowlby, president of The Eagle-Picher Lead Company, and W. F. Murdock, general manager of Eagle-Picher's Metallic Products Division.

Products of the newly acquired Dallas plant will be sold under the Eagle-Picher name, but the personnel of Southern Lead Company will be retained under terms of the agreement. J. V. Murph will serve as general manager of the Dallas plant, D. Bentley Murph will be in charge of production at that plant, and D. H. Murph, founder, will remain in a consulting capacity. Operations will be conducted under the newly created firm name, Eagle-Picher Company of Texas, with the three Messrs. Murph serving as vice presidents.

Junior AIME meeting

"Range of Application of Artificial Lifting Methods" was the subject of the February meeting of the Junior Division of the Southern California Section of AIME. The speaker was E. C. Babson, production foreman at Dominguez for the Union Oil Company.

Babson described 6 years of gas lift. Optimum well or reservoir properties for each type were pointed out. Several slides were shown that illustrated the operating characteristics of the gas lift. In his talk Babson compared the relative merits of hydraulic and rod pumps.

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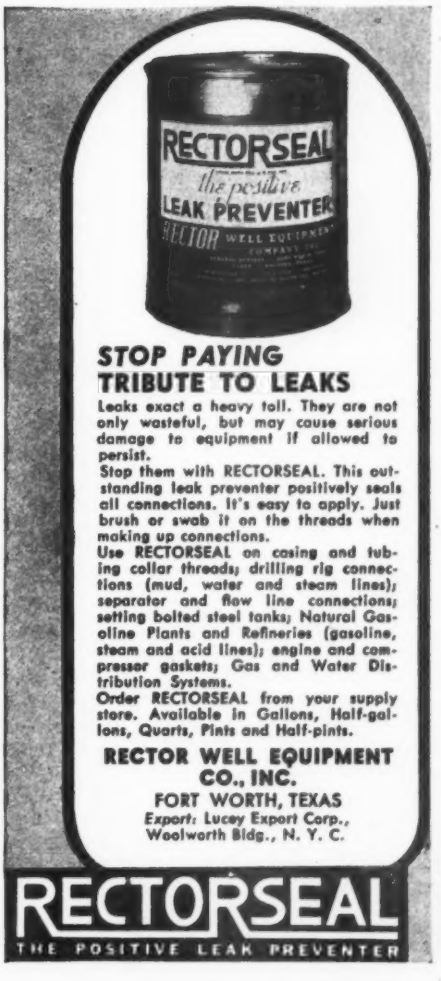

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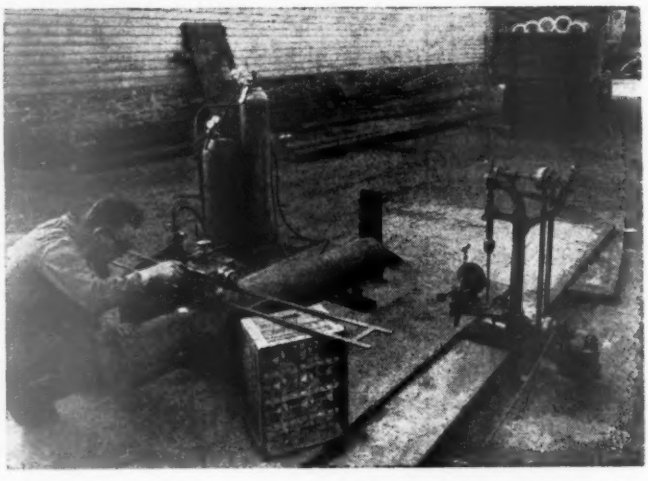
Cutting extra-heavy tubing

When extra-heavy-walled tubing requires cutting, and regular hand-operated machines are unavailable or over-burdened with work, an effective recourse may be had to an ingenious oxyacetylene flame cutting method conceived by a Brooklyn manufacturer who devised a shop-built emergency set-up to be used on 6-in. I.D. seamless tubing weighing 150 lb. per ft.

Under the pressure of a navy order, and lacking machine



—Courtesy Air Reduction Sales Co.

Tubing revolves beneath a stationary torch as the drill press reels in wire wrapped around the tube.

equipment capable of the work, the manufacture, F. J. Valentine, Inc., was compelled to make use of a collection of odd parts, in addition to an old drill press, in piecing together an unimposing but very practicable contrivance for cutting the tubing.

As shown by the illustration, the device serves to support and revolve the tubing beneath a stationary cutting torch mounted on a radiograph. Rotation is provided by the drill press set-up, which, by means of a worm gear reduction, slowly reels in a wire wrapped around the tubing. The circumferential speed of the tube is regulated to conform to the torch cutting speed, and remains constant at one revolution in three minutes as the wire is drawn in and coiled around a ½-in. shaft.

End play movement of the tube during cutting is eliminated by pitching it downward toward the "drive" end by elevating one of the dollies a few inches. A roller welded to a vertical support at the drive end maintains the tube in this position by butting against the end surface. Cutting is done at the opposite end, using 3/16-in. drilled holes for starting each cut through the 1¾-in. walls of the tube.

Dr. Emmett joins Mellon Institute

Dr. Paul Hugh Emmett, a chemist who has distinguished himself by his researches on catalysis, has been added to the investigational staff of Mellon Institute.

Dr. Emmett, born in Portland, Oregon, in 1900, received his B.S. in chemical engineering at Oregon State College in 1922. His graduate work was pursued at California Institute of Technology, where he was awarded the degree of Ph.D. in 1925. In 1939 Oregon State College conferred on him an honorary Sc.D. He was engaged in studies on catalysis at the Fixed Nitrogen Laboratory of the U. S. Department of Agriculture, Washington, D. C., from 1926 to 1937, with the final rank of senior chemist, and during that period served as lecturer on catalysis at George Washington University. From 1937 until his appointment at Mellon Institute he was professor of chemical and gas engineering at Johns Hopkins University and also consultant of the U. S. Department of Agriculture. Recently he has been productively active in wartime essential research for the U. S. government, on leave of absence from Johns Hopkins.

Dr. Emmett has made many notable contributions to the literature of adsorption and nitrogen fixation as well as catalysis. He is also an associate editor of the *Journal of the American Chemical Society*. At Mellon Institute he will plan and supervise long-range investigational projects on catalysis.

Export representative

Elmer R. Smith, formerly in charge of foreign activities for Lane-Wells Company, is now specializing in export representation for a group of oil equipment manufacturers. With offices in the Oviatt Building, Los Angeles, he is now representing in foreign fields the following companies: H. C. Smith Oil Tools Company, MacClatchie Manufacturing Company, and Plastik Company of America. Smith was with Lane-Wells Company for 11 years, the last 6 in export work. Before that he was with Martin-Decker Corporation for 3 years and with Shell and Richfield for 3 years. He is planning a trip to South American countries in the very near future.

Elk Hills reserve inspected

With development work about 3 months ahead of schedule, the House Naval Affairs Sub-Committee found on an inspection trip to Naval Petroleum Reserve No. 1 at Elk Hills, California, early in February, that production had already passed 53,000 bbl. per day. The total production of 65,000 bbl. per day set by Congress for the duration of the war will be reached in April. Under the Unit Plan Contract between the Navy Department and Standard Oil Company of California, 145 producing wells had been completed in the shallow zones by the end of January. Nineteen rigs are doing the drilling. Although a few wells were previously completed in the deep zones, these zones will not be developed by the present project.[1]

The present program necessitates only the drilling of shallow zone wells in the easterly part of the 43,000 acres comprising the reserve. Plans will be formulated for drilling exploratory wells to determine the reserves in both the upper and lower zones of the western portion and the deep zones in the eastern portion. These plans will then be submitted to the Congress for approval and for appropriation of funds necessary to carry on the work.

The congressmen present on the trip were: Edouard V. Izac, chairman, California; Lansdale G. Sasscer, Maryland; L. Mendel Rivers, South Carolina; F. Edward Hebert, Louisiana; Ray J. Madden, Indiana; Franck R. Havenner, California; Hugh DeLacy, Washington; Andrew J. Biemiller, Wisconsin; James W. Mott, Oregon; W. Sterling Cole, New York; George J. Bates, Massachusetts; William E. Hess, Ohio; John Z. Anderson, California; Robert A. Grant, Indiana, and Harry L. Towe, New Jersey. Jesus T. Pinero, resident commissioner of Puerto Rico was also present.

Capt. W. G. Greenman, USN, Director of Naval Petroleum Reserves, and Capt. Donald J. Ramsey USN, legislative counsel, accompanied the congressional party from Washington. At a meeting held before the inspection trip addresses were made by Capt. H. P. Stolz USNR and V. O. Wankowski, Standard Oil Company of California, members of the operating committee for the Navy and Standard, respectively. A reserve estimate of Elk Hills was presented by Capt. V. H. Wilhelm USNR. Details of operation were then presented by Fred Tratt, superintendent of the Unit Operation and by several other of the Navy and Standard Oil Company personnel.

[1]**Operating procedure and surface data were given in "Efficient Development of Elk Hills Now Under Way," *The Petroleum Engineer*, September 1944.**

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Made sales manager

W. E. (Eddie) Graves has been appointed sales manager of The Steel Improvement and Forge Company, manufacturers of drop, upset, and press forgings and forged boiler and tank accessories. He has been with the company for 5 years and has recently been in charge of priority and traffic matters.

New contracting firm

General Contractors of Texas is the firm name of a new concern that has been established in Wichita Falls, to engage in building sewer and water systems, and in general contracting work. General is now working on the clearing of 5000 acres of land in Archer County, Texas, the site of the new water supply lake for Wichita Falls, and will fence the lake area. They are bidding on water supply systems for townships of the surrounding area.

The partnership is made up of D. D. Vaughn, F. S. Cochran, and M. E. Conkling, and personnel consists of experienced oil and gas pipeline men, dirt moving operators, and specialized transit water pipe men. Their equipment includes trucks, bulldozers, ditching machines, power hole diggers, power saws, and all accessory equipment.

Buy Youngstown Miller

Walter Kidde and Company, Inc., of Belleville, New Jersey, announces that as of January 10, 1945, they have purchased the capital stock of the Youngstown Miller Company, Inc., formerly of Sandusky, Ohio, manufacturers of plastic coaters and oil reclaimers. Orders on hand will continue to be filled under the direction of F. L. Gerin, who becomes vice president and general manager. Other officers of the new subsidiary of Walter Kidde and Company, Inc., will be John F. Kidde, president; Harold A. Cartier, vice president; G. Crosby Hiss, secretary, and William Deyersberg, treasurer and comptroller. R. E. Strobel will continue as sales manager for the Youngstown Miller products.

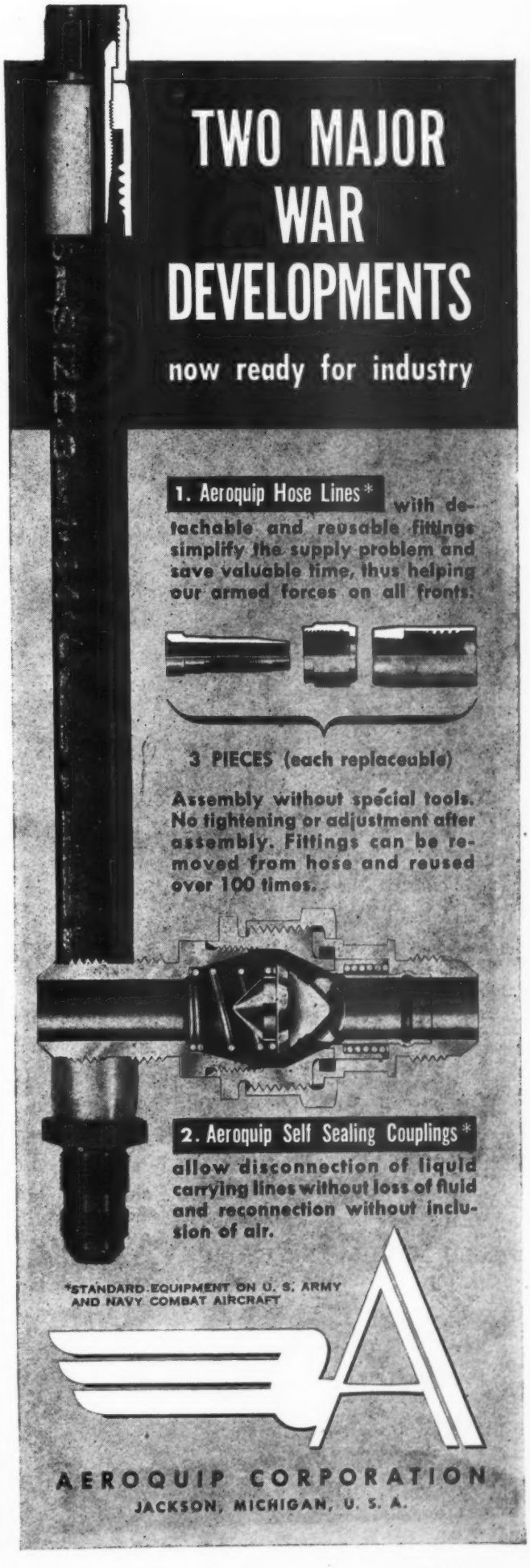
The Youngstown Miller Company for the last 10 years has been recognized as manufacturers of an outstanding line of batch reclaimers for all types of lubricating, hydraulic, and cutting oils. They recently developed the robot refiner for continuous cleansing operations of large quantities of oil in constant process use. Other products that this company will continue to manufacture and sell include a complete line of plastic coaters for melting ethylcellulose and other plastics used in coating parts with a waterproof, corrosion-resistant protection for overseas shipment or storage. These machines are suitable for continuous hand-dipping operation and may be adapted to conveyor application. They meet all existing requirements set up by military agencies and compounders of material for handling this type of plastic coating, and are extensively used by the army and navy for coating parts. YM plastic coaters embrace many important features not found in similar equipment, including extremely close control of temperatures over both the heat exchange medium and the plastic, removal of film and bubbles formed by dipping, constant level of dipping surface, and controlled agitation.

Sale of these products will continue through selected distributors and representatives of the parent company. The main office of The Youngstown Miller Company will be at 675 Main Street, Belleville, New Jersey.

Powers award to W. E. Pratt

Wallace Everette Pratt of New York City, internationally known petroleum geologist and director of Standard Oil Company of New Jersey, has been chosen as the first recipient of the Sidney Powers Memorial Award of the American Association of Petroleum Geologists. The announcement of the selection was made by Ira H. Cram of The Pure Oil Company, association president.

This new award, established in 1943, is "in recognition of distinguished and outstanding contributions to and achievements in petroleum geology." The selection committee, made up of 10 association members and 2 ex-officio members, is headed by A. Rodger Denison, of the Amerada Petroleum Corporation, Tulsa. The award is in memory of the late Sidney Powers, one of America's best known petroleum geologists and known throughout the profession as a "geeologist's geologist."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Assembly without special tools. No tightening or adjustment after assembly. Fittings can be removed from hose and reused over 100 times.
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SUPERIOR DROP-FORGED TOOLS
"VULCAN"
Drop-forged
CHAIN PIPE VISES

Above: "VULCAN". 4 sizes for pipe 1/8 to 8 inches.

At right: "VULCAN SUPERIOR", with reversible jaws and adjusting handle on top. 2 sizes for pipe 1/8 to 4-1/2 inches.

"Vulcan", the original chain pipe vise, is made entirely of tough, wrought steel ... no cast parts whatever. The dropforged jaws are of saw-tempered steel for file sharpening . . . chains are of the same high quality as Williams' "Vulcan" Tongs. Fully guaranteed, and sold by Industrial, Plumbing and Oil Field Distributors everywhere.

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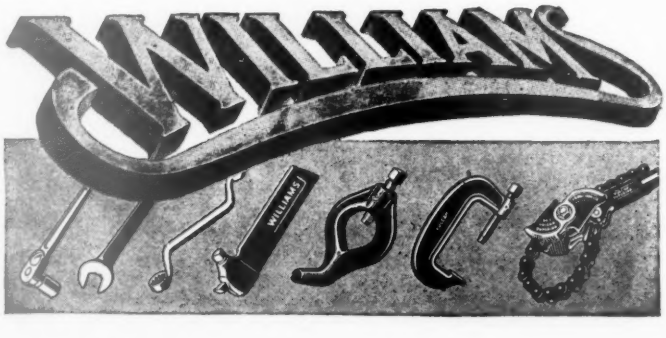

Officers for New York Nomads

Pictured are the newly elected officers of the New York chapter of Nomads. Standing, left to right: C. R. Tunnell, International General Electric Company, treasurer; E. L. Carter, export representative, assistant treasurer; W. H. Siems, Hughes Tool Company, regent; H. J. McAdams, Jones and Laughlin Steel Company, sergeant-at-arms, G. V. Leece, Gardner-Denver Company, assistant sergeant-at-arms; J. W. Reed, Cooper-Bessemer Corporation, assistant secretary. Sitting, left to right: R. M. Dinges, secretary; E. H. Trammel, Mission Manufacturing Company, president; W. G. Foster, Anglo-American Purchasing Company, vice president. W. J. Campbell, retiring president, was elected to the board of regents, but was not present when the picture was taken.

Sell plants

Sale of the five oil field repair plants, which have been operated by the American Iron and Machine Works Company, is announced by Earl H. Miller, vice president and general manager of the company.

The Great Bend, Kansas, shop has been sold to C & W Machine Works; the Monahans, Texas, shop to the Miller-Nelson Machine Works; the Houston, Texas, shop to L & H Machine Works; the New Iberia, Louisiana, shop to The Red Fox Machine and Supply Company, and the Harvey, Louisiana, shop to Young-Elkins Machine and Supply Company.

American Iron and Machine Works Company will, in the future, concentrate on expanion of its manufacturing facilities at the Oklahoma City plant. The company will continue, however, to maintain its offices and warehouse at 2205 Quitman Street in Houston, Texas, for servicing the Texas Gulf Coast, Louisiana, and Mississippi.

Joe T. Castles has been transferred from New Orleans to Shreveport to service the Shreveport area and Mississippi. Austin Brashears will service South Louisiana from New Iberia. Fern E. Wagner has been transferred from Kansas to Midland, Texas. Tom L. Turner has been employed as service representative for Houston.

Assistant sales manager

W. R. Persons

The appointment of W. R. Persons as assistant sales manager has been announced by J. F. Lincoln, president of The Lincoln Electric Company, Cleveland, Ohio. Persons will act as assistant to C. M. Taylor, vice president and general sales manager.

Among his activities concerned with the advancement and supervision of the entire Lincoln sales program, Persons will assume the responsibility of developing certain specific fields for Lincoln products. In this connection he has been working on special assignments since his transfer to the Lincoln home office at Cleveland several months ago. He is also chairman of the firm's junior board of directors.

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Water-cooled head bearings • Choice of oil or water lubrication • Double Bearings in each bowl • Fully-enclosed impellers • Double Seal impellers.

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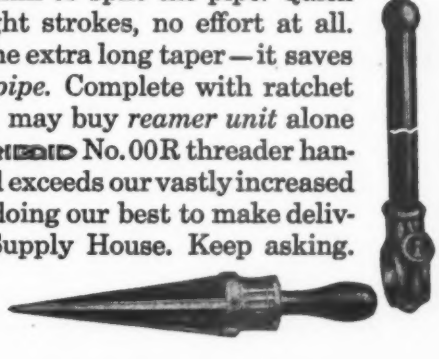
means safe, easy reaming of burr only

• It cuts the burr out clean as a whistle—but it doesn't gouge, thin or split the pipe. Quick easy feather-light strokes, no effort at all. The trick is in the extra long taper—it saves you work *and pipe.* Complete with ratchet handle—or you may buy *reamer unit* alone for use in your RIDGID No. 00R threader handle. War demand exceeds our vastly increased output—we're doing our best to make deliveries to your Supply House. Keep asking.



Reamer unit fits No. 00R ratchet threader handle.

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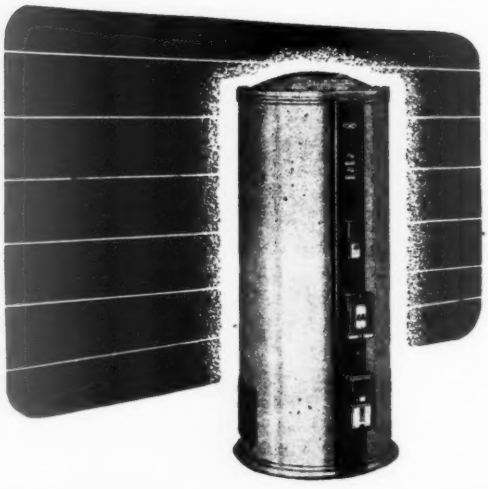
WORK-SAVER PIPE TOOLS
THE RIDGE TOOL COMPANY • ELYRIA, OHIO, U. S. A.



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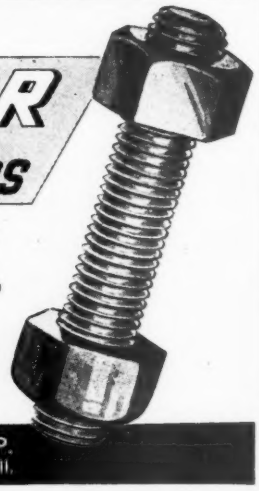

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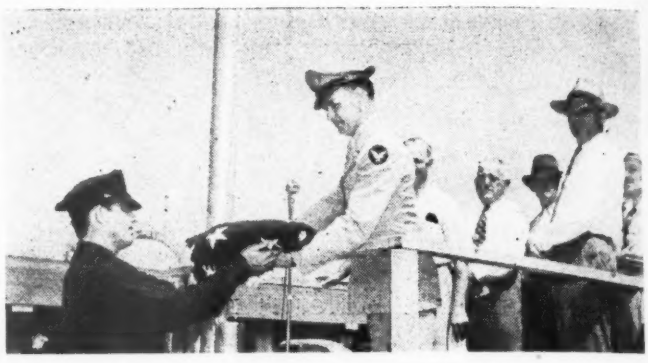
Old Glory flies at Paulsboro

Old Glory now flies over the new bead catalyst plant in Paulsboro (New Jersey) Refinery of Socony-Vacuum Oil Company, Inc. **Albert Hoffman,** operator in the plant, collected the amount needed for the purchase of the flag from employes of the plant.



Major "Jimmy" Happel presents the flag to Raymond Smith, member of the Plant Protection Force's color guard. On the platform are A. L. Grimme, H. W. Sheldon, Albert Hoffman, D. L. Hooker and Paul D. Valas.

At brief and impressive noon-hour ceremonies, Hoffman presented the flag to **Paul D. Valas,** foreman of the plant. He in turn presented it to **Major James Happel,** formerly third operator at the Houdry unit who was home on furlough after distinguished service in the European war theater—he has 158 missions over German-held territory to his credit. The flag, on being presented to the Plant Protection Force's color guard by Major Happel, was raised to the strains of the National Anthem. **A. L. Grimme,** industrial relations manager of the refinery, acting as master of ceremonies, then introduced **H. W. Sheldon,** manager of the refinery, and **D. L. Hooker,** member of the manufacturing committee. The names of the men who are represented on the refinery's service flag by gold stars were read by Hooker, as Old Glory was dipped in their memory and a prayer was said by the **Rev. Elmer Stewart**—pastor of Paulsboro Baptist Church who is active in the plant's credit union.

Officers Fort Worth engineers

Pictured from left to right are the new officers of the Petroleum Engineers' Club of Fort Worth, Texas, as elected recently for the year 1945: A. F. Nixon, second vice president; Peter P. Gregory, secretary-treasurer; Rex E. Rader (seated), president; Don L. Harlan, first vice president, and Charles H. Pishny, executive vice president.

To new offices

The Permutit Company, water conditioning specialists, announces the removal of its Los Angeles office to new and larger quarters at 405 South Hill Street, Los Angeles 13, California. The new telephone number is Madison 7755. U. A. Hammett will continue as district manager of this office, which covers the company's activities in the Southwest.

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« « « Advertisers Index » » »

Aeroquip Corporaiton 309
Affiliated National Hotels 313
Airetool Mfg. Company 309
American Air Filter Co., Inc. 128
American Cable Division of American Chain & Cable Co., Inc. Inside Back Cover
American Chain & Cable Co., Inc. ..... Inside Back Cover, 49, 274
American Cyanamid & Chemical Corp. 7, 219
American Inspection Service 196
American Meter Co., Inc. 144-145
American Roller Bearing Co. 292, 305
American Sand-Banum Co., Inc. 260
American Steel & Wire Co. 27
Armstrong Bros. Tool Co. 307
Audel, Publishers 306
Axelson Mfg. Co. 28
Baash-Ross Tool Co. 97
Babcock & Wilcox Tube Co. 63
Baker Oil Tools, Inc. 289
Baldwin Locomotive Works 23
Bantam Bearings Div., Torrington Co. 280
Barco Mfg. Co. 36
Baroid Sales Div. 26
Barrett Division, Allied Chemical & Dye Corp. 130
Beaird, J. B., Company 164-165
Bethlehem Steel Company 79
Bethlehem Supply Company 30
Boyd, Clarence L., Co., Inc. 238
Braden Steel Corporation 236
Bros Boiler & Manufacturing Co. 156
Brown Instrument Company 221
Buckeye Traction Ditcher Co. 213
Bucyrus-Erie Co. 62
Byron Jackson Co. 151
Cameron Iron Works, Inc. 259
Cardwell Mfg. Co., Inc. 154
Carey, Philip, Mfg. Company 152
Case, J. I., Company 300
Chapman Valve Mfg. Co. 129
Chicago Bridge & Iron Company ..... Inside Front Cover
Clark Bros. Company 167-168
Cleveland Trencher Co. 201
Continental Machines, Inc. 69
Continental Motors Corp. 65
Continental Supply Co. 67
Cook, C. Lee, Mfg. Co. 147
Cooper-Bessemer Corp. 92-93
Crane Co. 74
Cummins Engine Co. 15
Curtin, W. H., Co. 306
Darling Valve & Mfg. Co. 149
Dean Brothers Pumps, Inc. 78
Dearborn Chemical Co. 197
Dempsey, O. E., Construction Co. 125
Detroit Diesel Engine Div., General Motors Corp. 40
Diamond Chain & Mfg. Co. 57
Dollinger Corp. 177
Dowell Incorporated 21
Dresser Manufacturing Co. 123
Durametallic Corp. 195
Economy Electric Lantern Co. 306
Edward Valve & Mfg. Co., Inc. 225
Emsco Derrick & Equipment Co. 71
Ensign Carburetor Co., Ltd. 239
Fairbanks Co. 64
Fairbanks, Morse & Co. 6
Federal Telephone & Radio Corp. 142
Felt Products Mfg. Co. 295
First National Bank in Dallas 304
Floridin Co. 66
Fluor Corporation, Ltd. 175
Foster Wheeler Corp. 249-250
Forman-Richardson-Baird 220
Four Wheel Drive Auto Co. 243
France Packing Co. 284
Franklin Supply Co. 183
Gardner-Denver Company 75
Gaso Jump & Burner Mfg. Co. 178
Gearench Mfg. Company 158
General Electric Co. 3
General Manufacturing Co. 158
General Paint Corp. 206
Grant Oil Tool Co. 257
Griscom-Russell Co. 270
Guiberson Corp. 4
Gunite Concrete & Construction Co. 312
Gustin-Bacon Mfg. Company 173
Haering, D. W., & Co., Inc. 298
Halliburton Oil Well Cementing Company ..... Back Cover
Hamer Oil Tool Company 215
Hammond Iron Works 210-211
Hamner, Leland, Company 307
Hanlon-Waters Company 37
Happy Company 73
Harrisburg Steel Corporation 286
Hazard Wire Rope Div., American Chain & Cable Co. 274
Hill, Hubbell & Co. Division, General Paint Corp. 206
Honan-Crane Corp. 312
Horrigan, J. R., Construction Co. 199
Houdry Process Corp. 58
Hughes Tool Co. 100
Humble Oil & Refining Company 209
Hunt Tool Company 285
Hyatt Bearings Div., General Motors Corp. 272
Hycar Chemical Co. 115
Ingersoll-Rand 180-181
International Derrick & Equipment Co. 41
International Harvester Company 45
Jacobs Wind Electric Company, Inc. 220
Jarecki Mfg. Co. 247
Jensen Bros. Mfg. Co. 313
John-Manville Corp. 297
Jones & Laughlin Steel Corp. 54
Jones & Laughlin Supply Co. 68
Justrite Mfg. Co. 296
Kellogg, M. W., Company 112-113
Kerotest Mfg. Co. 127
Keuffell & Esser Co. 158
Kobe, Incorporated 43
Ladish Drop Forge Co. 99
Lane-Wells Co. 263
Larkin Packer Co., Inc. 104-105
Layne & Bowler, Inc. 258
LeRoi Co. 133-134
Leschen, A., & Sons Rope Co. 13
Lincoln Electric Co. 140-141
Linde Air Products Company 193
Line Scale Co., Inc. 307
Link-Belt Company 48, 293
Lockwood Kessler & Bartlett 216
Lone Star Cement Corp. 61
Ludlow Valve Mfg. Co., Inc. 308
Lufkin Foundry & Machine Co. 102
Lummus Co. 9-10
McCullough Tool Co. 77
Maloney, F. H., Co. 160-161
Marley Company, Inc. 25
Marsh, Jas. P., Corp. 227
Maxim Silencer Co. 278
Mayo Hotel 313
Mearl Corporation 117
Merco Nordstrom Valve Co. ..... Front Cover
Midco Bailer Co. 254
Midwestern Constructors 223
Midwest Piping & Supply Company, Inc. 51
Mission Mfg. Co. 70
Moore, Lee C., & Co. 50
Murphy Diesel Company 261
Nash Engineering Company 282
National Airoil Burner Company, Inc. 78
National Carbon Company 60
National Radiator Company 38
National Supply Company 55
National Technical Laboratories 35
Naylor Pipe Company 176
Nelson Specialty Welding Equipment Corp. 34
Norris, W. C., Manufacturer, Inc. 1
Ohio Injector Company 72
Orbit Valve Company 230
Otis Pressure Control, Inc. 32
Pacific Pumps, Inc. 47
Parkersburg Rig & Reel Co. 59
Parkhill Truck Company 237
Parsons Company 224
Patterson-Ballagh Corp. 287, 306
Peerless Pump Div., Food Machinery Corp. 311
Penberthy Injector Co. 19
Petro-Chem Development Co. 108
Petroleum Electric Power Association 232
Perrault Brothers 207
Petroleum Rectifying Co. 76
Phillips Petroleum Co., Perco Div. 5
Phoenix Manufacturing Company 231
Pittsburgh-Des Moines Steel Co. 191
Powell, Wm., Co. 2
Pressure Weld Company 189
Price, H. C., Company 203
Pyrene Mfg. Company 248
Reading-Pratt & Cady Div., American Chain & Cable Co., Inc. 49
Rector Well Equipment Company, Inc. 307
Reed Roller Bit Company 80
Refinery Supply Co. 301
Reilly Tar & Chemical Corp. 204
Republic Flow Meters Co. 235
Republic Steel Corporation 33, 118
Ridge Tool Co. 66, 311
Robinson Packer Company 262
Rockford Drilling Machine Div. 313
Rodgers Hydraulic, Inc. 217
Roebling's, John A., Sons Co. 228-229
Ruberoid Company 185
Shafer Bearing Corporation 126
Sheehan Pipe Line Const. Company 237
Smith Contracting Co. 198
Smith Meter Company 245
Southern Mill & Mfg. Co. 241
Spang & Co. 299
Specialty Sales Company 308
Sperry-Sun Well Surveying Co. 311
Standard Oil Company of Calif. 31
Stearns-Roger Mfg. Co. 205
Sterling Engine Co. 56
Stoody Co. 218, 288, 294
Superior Equipment Company 155
Tank Seal Products Company 234
Taylor Forge & Pipe Works 265
Technical Oil Tool Corp., Ltd. 95
Texaco Development Corporation 42
Texasteel Mfg. Co. 106
Thermoid Co. 29
Tobin, Edgar, Aerial Surveys 187
Torrington Co., Bantam Bearings Div. 280
Tretolite Co. 46
Tube-Turns, Inc. 255
Twin Disc Clutch Co. 157
Union Asbestos & Rubber Co. 44
Union Carbide & Carbon Co. 193
United States Motors Corp. 302
United States Treasury Dept. 11
United Supply & Mfg. Company 303
Universal Oil Products Co. 111
Van der Horst Corp. 39
Victaulic Company of America 171
Victor Products Corp. 312
Visco Products Company, Inc. 276
W-K-M Company 253
Wailes Dove-Hermiston Corp. 163
Waukesha Motor Company 291
Wedge Protectors, Inc. 240
Whitaker, O. C., Co. 212
Whitney Chain & Mfg. Co. 268
Williams Brothers Corp. 124
Williams, J. H., Co. 310
Wilson Manufacturing Co., Inc. 266
Wilson Supply Co. 52
Wisconsin Motor Corp. 295
Worthington Pump & Mch. Corp. 136, 138
Youngstown Sheet & Tube Co. 53

1
72
230
32
47
59
237
224
287, 306
311
19
108
232
207
76
5
231
191
2
189
203
248
49
307
80
301
204
235
33, 118
66, 311
262
313
217
228-229
185
126
237
198
245
241
299
308
311
31
205
56
288, 294
155
234
265
95
42
106
29
187
280
46
255
157
44
193
302
11
303
111
39
171
312
276
253
163
291
240
212
268
124
310
266
52
295
36, 138
53

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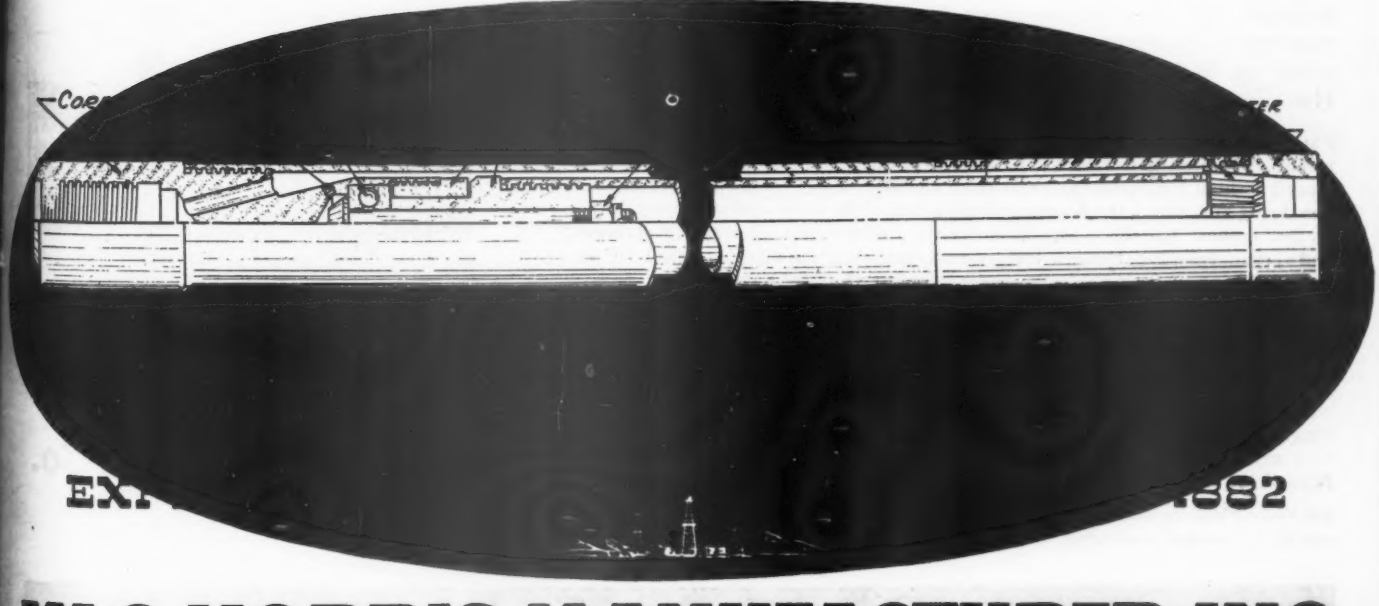

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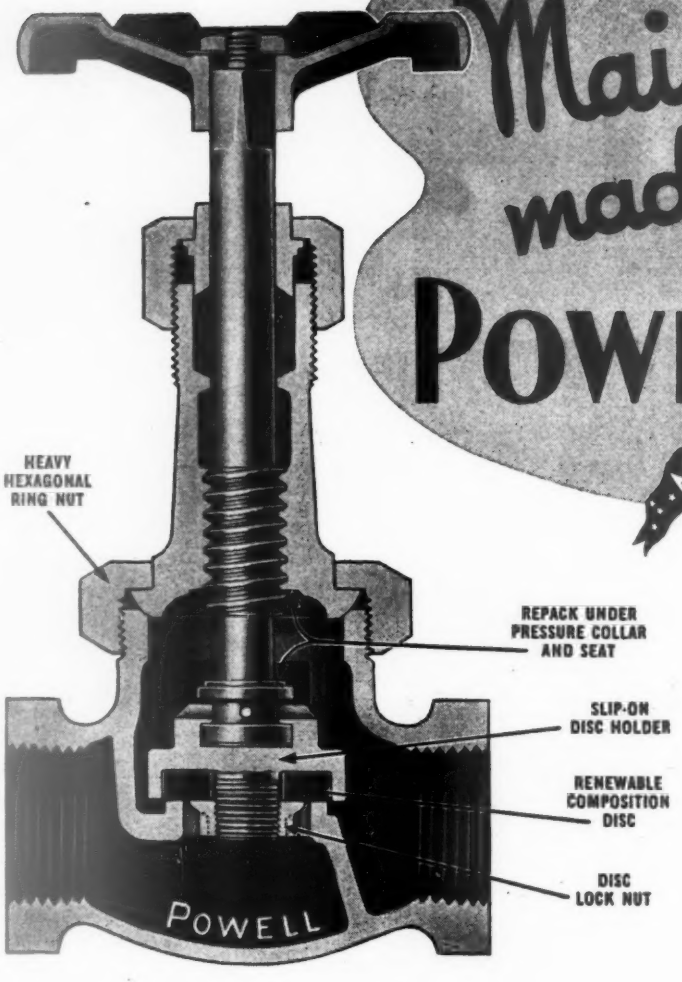

Fig. 150
BRONZE "UNION" COMPOSITION DISC GLOBE VALVE

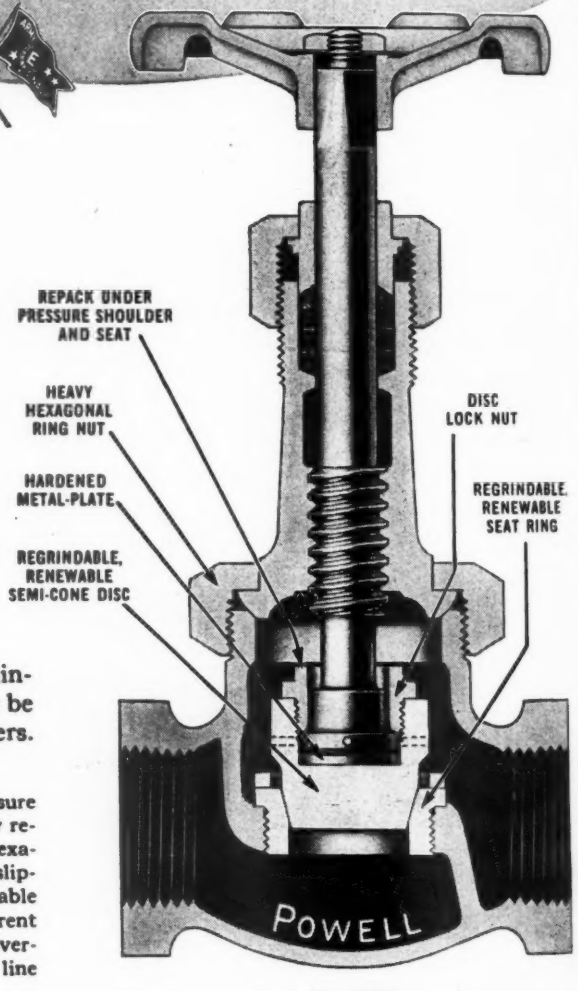

Fig. 1708
BRONZE "WHITE STAR" GLOBE VALVE

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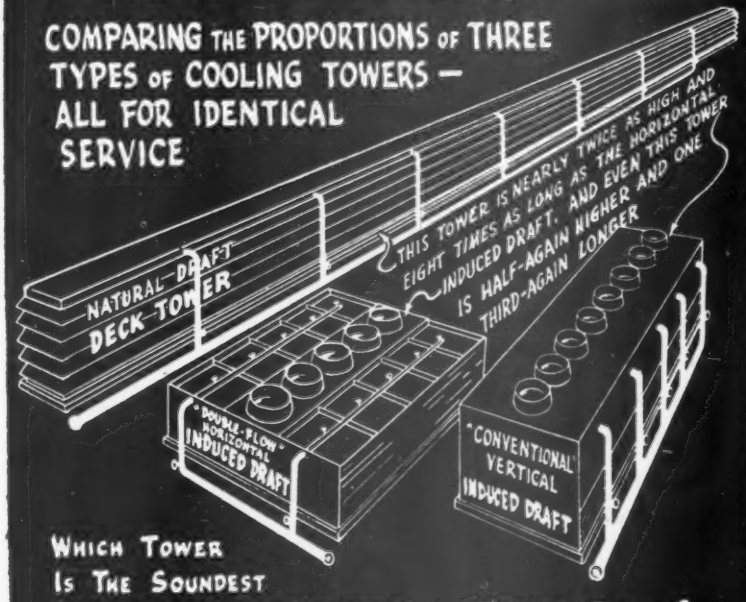
COMPARING THE PROPORTIONS OF THREE TYPES OF COOLING TOWERS — ALL FOR IDENTICAL SERVICE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WHICH CAN BE MOST CONVENIENTLY LOCATED AT MOST PLANTS?

REDWOOD vs. STEEL—Redwood is the principal structural material in all but a small fraction of the total cooling tower capacity installed today. In towers of more than a few hundred GPM, steel is rarely to be preferred. Steel costs more, its service life is not as long, general maintenance greater. It requires frequent and liberal painting with aluminum-base paint inside and out to retard corrosion, whereas Redwood's natural preservatives render painting unnecessary. However if a Redwood tower is painted (for color harmony or to carry an advertising sign) it requires only standard paint, only infrequently, and only on the outside. Fire and safety ordinances which once banned any wood structures on roofs in business areas of some cities now have been modified widely in the case of Redwood due to its proven resistance to burning, its retention of strength in defiance of age and weather, its freedom from all forms of organic attack.

FRAMING—Equally as important as proper size, quality and quantity of members is that connections be sound, snug-fitting, full-bearing, with proven timber connectors (such as "Teco" rings) at critical joints; and footings, angle-washers and other structural hardware as required. Unit working stresses and other values should conform to recommendations of the U. S. Forest Products Handbook. Bolts should be used throughout, with no dependence on nails and no credit for structural strength given to the casing or other non-frame parts.

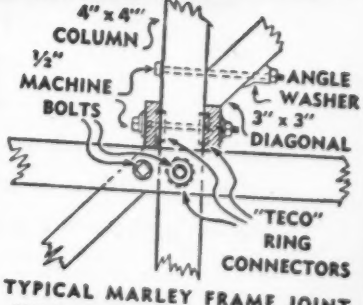
CASING—Walls should be double, with air space between, or otherwise provide for internal drainage of water on the inner surfaces to avoid seepage and unsightly exterior staining. Casing should be applied in a manner to permit necessary expansion and contraction without stress to frame or casing, and to present a smooth, neat exterior.

SAFETY & CONVENIENCE—Adequate stairs, ladders, walks, doors, guards and railings should be provided for safe and convenient access to all parts of tower requiring inspection and service.

MARLEY COOLING TOWERS

94-A

DO YOU KNOW — snug fit, full bearings, uniform workmanship and sound materials are assured in all frame members and other Redwood parts of Marley towers by 100% *pre-fabrication* in Marley's two large wood-working plants (Stockton, Calif., and Kansas City, Kans.) thoroughly equipped for this exacting service. Marley's structural superiority is a recognized fact, zealously maintained.



TYPICAL MARLEY FRAME JOINT

THE MARLEY COMPANY, INC. · KANSAS CITY · KANSAS

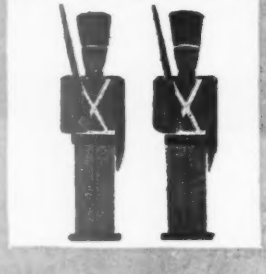
BAROID PRODUCTS AND SERVICE STILL UNSURPASSED

Since 1926, when Baroid was first introduced to the oil industry, Baroid Products and Service have made valuable contributions to faster, safer, more economical drilling.

Today, Baroid Products and Service are still unsurpassed because of many reasons — a few of which are described below:

MANUFACTURING EXPERIENCE — Latest-type processing equipment, designed especially for Baroid Sales Division and operated by men of long experience, processes the crude materials so that only the highest grade products are produced.

AVAILABILITY — Since 1926, Baroid Sales Division has continually increased the number of Distributors and Sub-Distributors of BAROID and other Baroid Products. Today, these products are available in 438 locations in the United States and Canada.



UNIFORMITY — Absolute uniformity is one of the many outstanding advantages of BAROID and other Baroid Products. This uniformity is reflected in the unsurpassed efficiency and economy of these products which have been used to help prevent drilling troubles in hundreds of thousands of wells throughout the world.

FIELD SERVICE—Competent Baroid Service Engineers, strategically located and supplied with laboratory-equipped cars, have helped to solve thousands of mud problems in active drilling areas throughout the United States. Available day or night, these Engineers test drilling muds and recommend procedure right at the well.

LABORATORY SUPERVISION — The industry's most modern and completely equipped Laboratories maintain and improve the quality of BAROID and other Baroid Products. These Laboratories, located at Los Angeles, Tulsa and Houston, also develop new materials, new applications and new processes for the prevention of drilling troubles.

Patent Licenses unrestricted as to sources of supply of materials, but on royalty bases, will be granted to all companies and others desiring to practice the subject matter of any and/or all of United States Patents Numbers 1,807,082; 1,991,637; 2,041,086; 2,044,758; 2,064,936; 2,094,316; 2,119,829; 2,214,366; 2,294,877; 2,304,256 and further improvements thereof. Applications for Licenses should be made to Los Angeles office.

BAROID SALES DIVISION

NATIONAL LEAD COMPANY

BAROID SALES OFFICES: LOS ANGELES 12 • TULSA 3 • HOUSTON 2

BAROID PRODUCTS: ANHYDROX • AQUAGEL • AQUAGEL CEMENT • BAROCO • BAROID • FIBROTEX • IMPERMEX • MICATEX • SMENTOX • STABILITE • ZEOGEL • TESTING EQUIPMENT • BAROID WELL LOGGING SERVICE

AMERICAN STEEL & WIRE COMPANY
Cleveland, Chicago and New York
COLUMBIA STEEL COMPANY
San Francisco
United States Steel Export Company, New York

USS STEEL
UNITED STATES STEEL

UNITED STATES STEEL

. . . An Authoritative Guide on Its Selection, Use and Care

JUST off the press—AMERICAN TIGER BRAND'S new catalog—125 pages crammed with illustrations, specifications and descriptive material to help you select the wire rope that's exactly right for your particular job. In addition, special chapters feature modern methods of splicing, socketing, lubrication, and other facts essential to the proper use and care of wire rope in every field.

This catalog covers the complete range of both AMERICAN TIGER BRAND Excellay Preformed and AMERICAN TIGER BRAND Standard Non-Preformed Wire Rope and accessories.

This valuable book, with its quick-reference indexed pages should be in the hands of every man who buys or uses wire rope. A request on your letterhead will receive prompt attention.

WITH THESE BRANDS

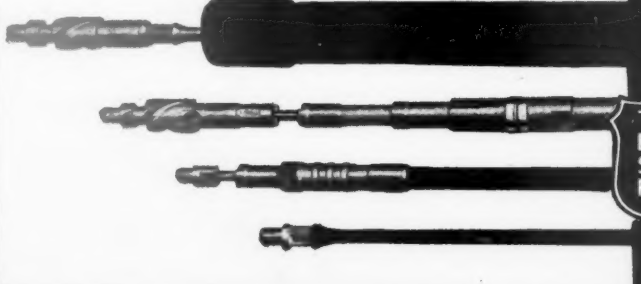
on your pumps you'll round up production

BUY WAR BONDS

AXELSON'S "brand" (A) stands for top grade stock on the oil derrick range . . . Coupled with the API-monogram, this pair of aces, back-to-back, gives you a mighty strong hand to draw to . . . Axelson has been making subsurface oil well equipment for half a century . . . Quality has always been the first consideration . . . Ride herd on these facts and you'll never have to buck a down-time stampede.

AXELSON MANUFACTURING CO.

PLANTS—6160 So. Boyle Avenue (P. O. Box 98, Vernon Station), Los Angeles 11, Calif. • 3844 Walsh Street, St. Louis 16, Missouri • OFFICES—50 Church Street, New York City 7 • National Bank of Tulsa Building, Tulsa 1, Okla. • Avda Pte. R. Saenz Pena 832, Buenos Aires, Argentina • DISTRIBUTORS—Jones & Laughlin Supply Company • Great Northern Tool & Supply Company • C. C. McDermond, Apartado 331, Maracaibo, Venezuela • Industrial Agencies, Ltd., San Fernando, Trinidad, B.W.I.



AXELSON

DEEP WELL PLUNGER PUMPS

AND SUCKER RODS

THERMOID COMPANY

Announces

THE ACQUISITION OF THE
LOS ANGELES PLANT OF THE

GRIZZLY MANUFACTURING CO.

THERMOID has long desired a factory on the Pacific Coast to provide better service for its Coast customers for both automotive and industrial products. The acquisition of the California plant of the Grizzly Manufacturing Company brings over 60 years of Thermoid product development and production experience to the Coast. It also eliminates freight and other differentials in preparation for the post-war market in the West.

The acquisition includes the complete line of Grizzly oil field, industrial and aviation products—and important patents covering them. These products combine naturally with Thermoid Products to form a greatly augmented, strengthened line. (Grizzly will continue manufacturing its automotive friction products in its Paulding, Ohio, plant.)

The oil field products of both Grizzly and Thermoid will be combined to service the oil field market which will be so important in the days ahead.

This acquisition marks another milestone in the development of Thermoid's long-term planning. It aids management's desire to produce and sell more products at lower cost. It means broader and better service and benefits to customers and friends of both Thermoid and Grizzly.

Thermoid
COMPANY
TRENTON, N. J., U. S. A.

THE GRIZZLY LINE INCLUDES

Oil Field Products

Rotary Brake Blocks
Drill Pipe & Tubing Protectors
Pressure-Seal Rotary Hose
"No-Wip" Line Saver
Wire Line Turn Back
Slush Pump Suction Hose

Aviation Products

Breather Tail Wheels
Drop Hammer & Hydro Press Pads
Friction Materials

Industrial Products

Air, Steam, Suction, Water Hose
Packing
Neoprene Sheet & Moulded Products
Transmission Belting
Drop Hammer & Hydro Press Pads
Sheeting & Moulded Products

All of these Grizzly Products will be added to the already broad lines of

THERMOID AUTOMOTIVE · INDUSTRIAL RUBBER · OIL FIELD · HARD RUBBER · PLASTIC · TEXTILE PRODUCTS

From Grass Roots to 15,000 Feet...

A Bethlehem Drilling Rig for every depth

Whether you're drilling a shallow well or one that takes you down three miles, Bethlehem can furnish you the right size of rotary-drilling outfit.

SELECT YOUR RIG FROM THIS LINE-UP:

- **MC-250 To 4,500 ft. with 4½-in. drill pipe**
- **MC-350 To 6,500 ft. with 4½-in. drill pipe**
- **MC-450 To 9,000 ft. with 4½-in. drill pipe**
- **MC-650 To 11,000 ft. with 4½-in. drill pipe**
- **MC-950 To 15,000 ft. with 4½-in. drill pipe**

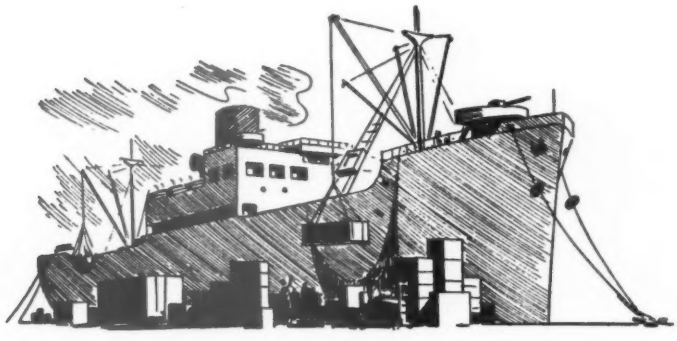
Bethlehem produces every item of power-driven rotary-drilling equipment, including slush pumps, draw works, rotaries, swivels, and matched crown and traveling blocks . . . all backed by half a century's experience in the development and manufacture of oil-country machinery.

Ask for details at the nearest Bethlehem Supply store or office.

BETHLEHEM STEEL

AMERICAN WELL AND PROSPECTING COMPANY
Subsidiary of Bethlehem Steel Company

Bethlehem Supply Offices or Stores: **Arkansas** — Magnolia; **Illinois** — Grayville, Salem; **Kansas** — Chase, Great Bend, Pratt, Russell, *Wichita; **Louisiana** — Harvey, Houma, Lake Charles, New Iberia, Shreveport; **Mississippi** — Laurel; **New Mexico** — Artesia, Hobbs; **Oklahoma** — Oklahoma City, *Ponca City, Seminole, Tulsa, Wewoka; **Texas** — Alice, *Amarillo, *Beaumont, Borger, Bowie, Corpus Christi, *Dallas, *Fort Worth, Graham, Houston, Kamay, Kermit, Kilgore, La Ward, McAllen, Odessa, Pampa, *San Antonio, Sundown, Wichita Falls, Winnsboro. (**Office only.*)



They're an All-American Wonder Team

Even on the West Coast—where so many people help build ships and man them—it's no easy task to picture ocean shipping these days. It's like trying to keep up with the astronomers and their million-billion distances.

What can give anything so big its sense and direction? Well, just think of a man with a wheelbarrow. Before the war, Pacific Coast ship operators were men with amphibian "wheelbarrows." Somebody would say "Deliver this flour" or "Move those bricks." Then they had a job. Often they had to trundle their "wheelbarrows" home empty.

Then came the war. Shipping expansion was terrific. New ships poured from the ways in hundreds. But they didn't start to pay off until they began hauling the stuff. That's where the ship operators came in. They had the stamina and the managerial know-how required when Uncle Sam suddenly needed *everything* delivered *everywhere.*

What a job they've done! Yet, today, that job is bigger than ever. We're at Japan's door. But that's so far away it takes, roughly, three ships to "git thar" with the goods that one ship could deliver to earlier, nearer battlefields. Japan's hope is that it can't be done. Ship operators know they have the answer—*Can do!*—in teamwork.

Already this teamwork has done wonders. To achieve it, ship operators have submerged their identity and passed up the chance to receive personal credit. No longer can you tell which man, which company—or which "wheelbarrow." But, whoever or wherever, the American people realize no team ever made a better record.

STANDARD OF CALIFORNIA

E flag, with 3 stars, awarded to our Richmond Refinery

OTIS PRESSURE CONTROL SERVICE - EQUIPMENT

Sub-Surface Facts

ON THE
CONTROL OF FLOWING WELLS

No. 20 | 1945 | DALLAS, TEXAS

GAS LIFT INSTALLATION SIMPLIFIED BY NEW OTIS TYPE "L" PERFORATOR

COMPLETE OPERATION DONE UNDER PRESSURE WITH ORDINARY STEEL MEASURING LINE WITHOUT MOVING TUBING OR KILLING WELL

Equipping a well for gas lift now requires only a few hours' time. No longer is it necessary to pull the tubing to install jet collars or flow valves. Instead, the Otis Tubing Perforator is used to drive inserts containing orifices of a desired size through the tubing walls and to securely lock them in place. The complete operation is done under pressure on an ordinary steel measuring line in much the same manner as a bottom hole choke is run and set.

NO EXPLOSIVES USED

Operated on an ordinary steel measuring line, the *New Otis Perforator* is basically of the same design as used successfully by *Otis* for the past several years. It is mechanical in operation—no explosives are used. Perforations can be made at any depth in the tubing string. A new tubing coupling finder eliminates any risk of attempting to perforate in tubing upset or coupling.

With the use of tubing jars, a small, hardened steel insert containing an orifice is driven through the tubing walls. The size of the orifices ranges from $\frac{1}{32}$" to $\frac{5}{32}$" in diameter. If a greater capacity is desired than will pass the largest insert, more than one may be used, or the insert can be eliminated altogether and an orifice of sufficient size punched directly through the tubing.

INSERT SECURELY LOCKED

The orifice insert is slightly tapered so that the hole punched into the tubing is expanded as the insert is driven to its ultimate position, which is $\frac{1}{32}$" beyond the inside diameter of the tubing. This permits the inside perimeter of the hole punched in the tubing to shrink back of the insert, locking it against backward movement. The taper, of course, prevents forward movement of the insert. So securely is the insert locked in place that 5000 p.s.i. pressure differential across the insert in either direction will not force it from its seat or cause it to leak.

To provide this perforating service to the industry, Otis Pressure Control, Inc., maintains at strategic points a fleet of highly mobile trucks fully equipped and manned with highly trained crews.

ACTUAL PHOTOGRAPHS OF PERFORATED SECTION

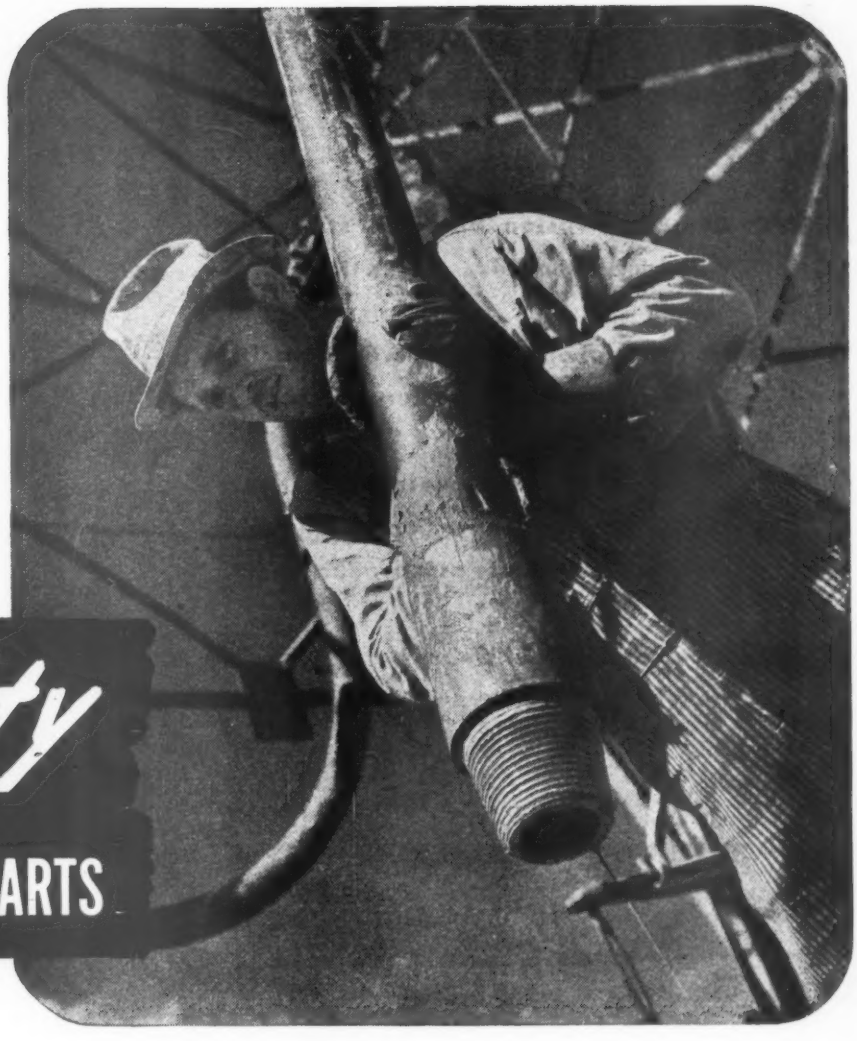
Section showing outside view of insert in place. Note lack of distortion of tubing and the perfect fit of the insert within the clean cut hole.

Section showing inside view. Note that insert is driven 1/32" beyond inside diameter of the tubing to allow the tubing to shrink or contract back of the insert and to lock it securely in place.

Section showing the tubing bore at the insert. Note that the tubing is still perfectly round and full opening.

Write now for New Wire Line Tubing Perforating Bulletin

OTIS PRESSURE CONTROL, INC.
DALLAS, TEXAS



For Safety in HIGHLY STRESSED PARTS

-No Other Material Can Equal ALLOY STEELS

When it becomes impracticable or impossible to further enlarge sections of operating parts to increase strength, especially where concentration of stresses occur, the answer probably will be found in Republic Alloy Steels. The tool joint illustrated above is an example.

Alloy steels provide an outstanding combination of qualities found in no other material—including those properties essential to safety in designing light-weight equipment to carry heavier loads at extreme depths.

For in alloy steels you will find highest strength values and the most favorable strength to weight ratio. You are assured greatest toughness. You have at your command the widest range of hardenability and a knowledge that hardened areas will be uniform in their resistance to wear.

Add to these qualities resistance to fatigue—an important quality in highly stressed working parts—resistance to heat and cold—resistance to corrosion—and you have a material with the ability to insure safety, to extend service life of equipment, and to cut maintenance and replacement costs.

Republic—world's leader in the production of alloy steels—is ready to discuss the advantages of alloy steels as applied to your individual uses.

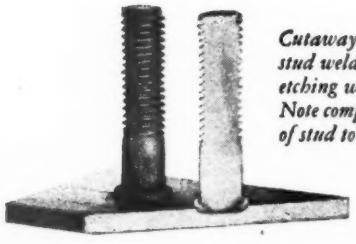
REPUBLIC STEEL CORPORATION
Alloy Steel Division • Massillon, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N. Y.

ALLOY STEELS

Also Casing—Tubing—Line Pipe—U

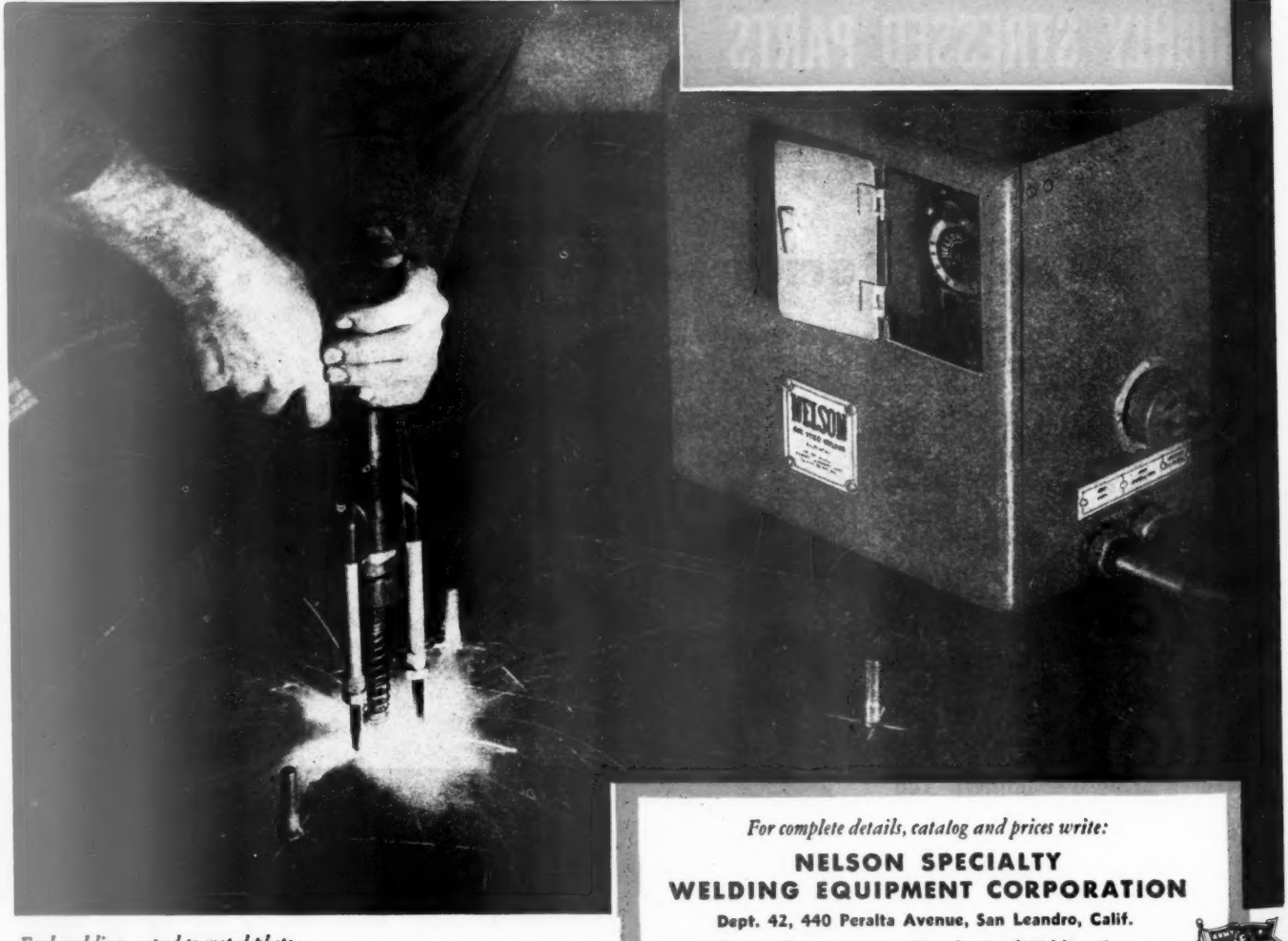
Automatically end-weld studs!

- Complete fusion between stud and metal in ½ second . . . Saves time.
- No drilling holes or hand-welding bolts. Studs are pointed for accurate locating.
- One operator can weld more than 1000 studs per shift. Completely portable. Also available as a production jig.
- Thousands of guns now being used in more than 500 shipyards and industrial plants.



Cutaway view of stud weld after etching with Nital. Note complete fusion of stud to metal.

NELSON
ELECTRIC ARC
STUD WELDERS



End-welding a stud to metal plate.

For complete details, catalog and prices write:

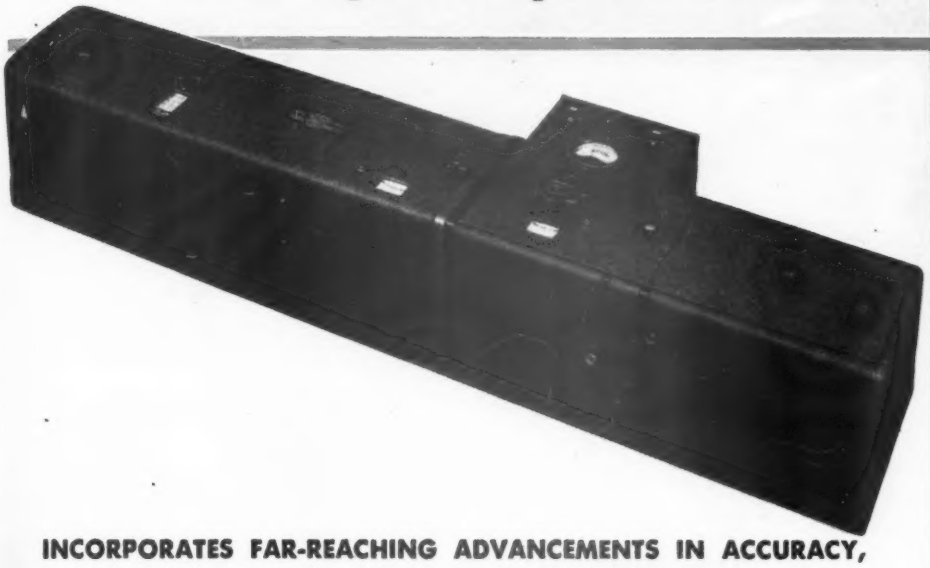
NELSON SPECIALTY WELDING EQUIPMENT CORPORATION

Dept. 42, 440 Peralta Avenue, San Leandro, Calif.

Eastern Representative: Camden Stud Welding Corp. Dept. 122, 1416 South 6th Street, Camden, N. J.

A Great New Stride in
Spectrophotometric Equipment

THE NEW BECKMAN IR-2 Infrared Spectrophotometer



INCORPORATES FAR-REACHING ADVANCEMENTS IN ACCURACY, ADAPTABILITY AND SIMPLIFIED OPERATION

JUST as the original Beckman Infrared Spectrophotometer made possible the first practical and widespread application of infrared methods for industrial process control, this new Beckman advancement marks another great step forward in spectrophotometric design and performance.

The Model IR-2 embodies many new and useful features resulting from the years of experience gained by the Beckman organization in producing more infrared spectrophotometers *than all other manufacturers combined.* While the earlier instruments were designed specifically for routine analysis of hydrocarbons, the new Model IR-2 emphasizes maximum adaptability to a wide range of general applications. It is equally suitable for routine analysis or research investigations—on gases, liquids or solids—and it provides many novel features not heretofore available in even the most expensive research instruments.

Under war emergency conditions only plants of urgent importance to the war effort have been able to purchase Beckman Infrared Spectrophotometers. But increased production is now making these instruments available for general laboratory and industrial use . . . and simultaneously Beckman is making available this new years-ahead instrument. If you are planning the purchase of spectrophotometric equipment, *it will pay you to investigate the new IR-2.*

Outlined at the right are a few of the important features of this advanced instrument. Write for more detailed information.

BECKMAN INSTRUMENTS

National Technical Laboratories • South Pasadena 26, California

INSTRUMENTS CONTROL MODERN INDUSTRIES

IMPORTANT FEATURES OF THE BECKMAN IR-2 SPECTROPHOTOMETER

• ***Unusual Versatility*** **is provided by interchangeable elements. Various types of light sources, cell holders, etc. can be interchanged to adapt the instrument to a wide range of applications on liquids, solids and gases. Even cells with path-length of a meter or more can be used.**

• ***Increased Accuracy and Stability*** **are obtained through use of a new energy measuring system employing a bolometer and vacuum tube amplifier. This system eliminates temperature drift, non-linearity errors and vibration difficulties that are characteristic of conventional thermopile-galvanometer systems.**

• ***Constant Temperature*** **insures accuracy at *all* wavelengths. The monochromator and cell compartments are thermostated, eliminating the uncertainty of inadequate "temperature compensation" and making a constant-temperature room unnecessary.**

• ***Quick Easy Readings*** **can be made directly in percent transmission and optical density, and provisions are made for direct-connecting a standard potentiometer-type recorder. The wavelength range is 1 to 15 microns and wavelengths can be selected either by a continuous wavelength drive calibrated directly in microns or by a 17-position stop-mechanism that greatly simplifies routine analysis operations. Accessory equipment includes a motor drive for continuous wavelength scanning.**

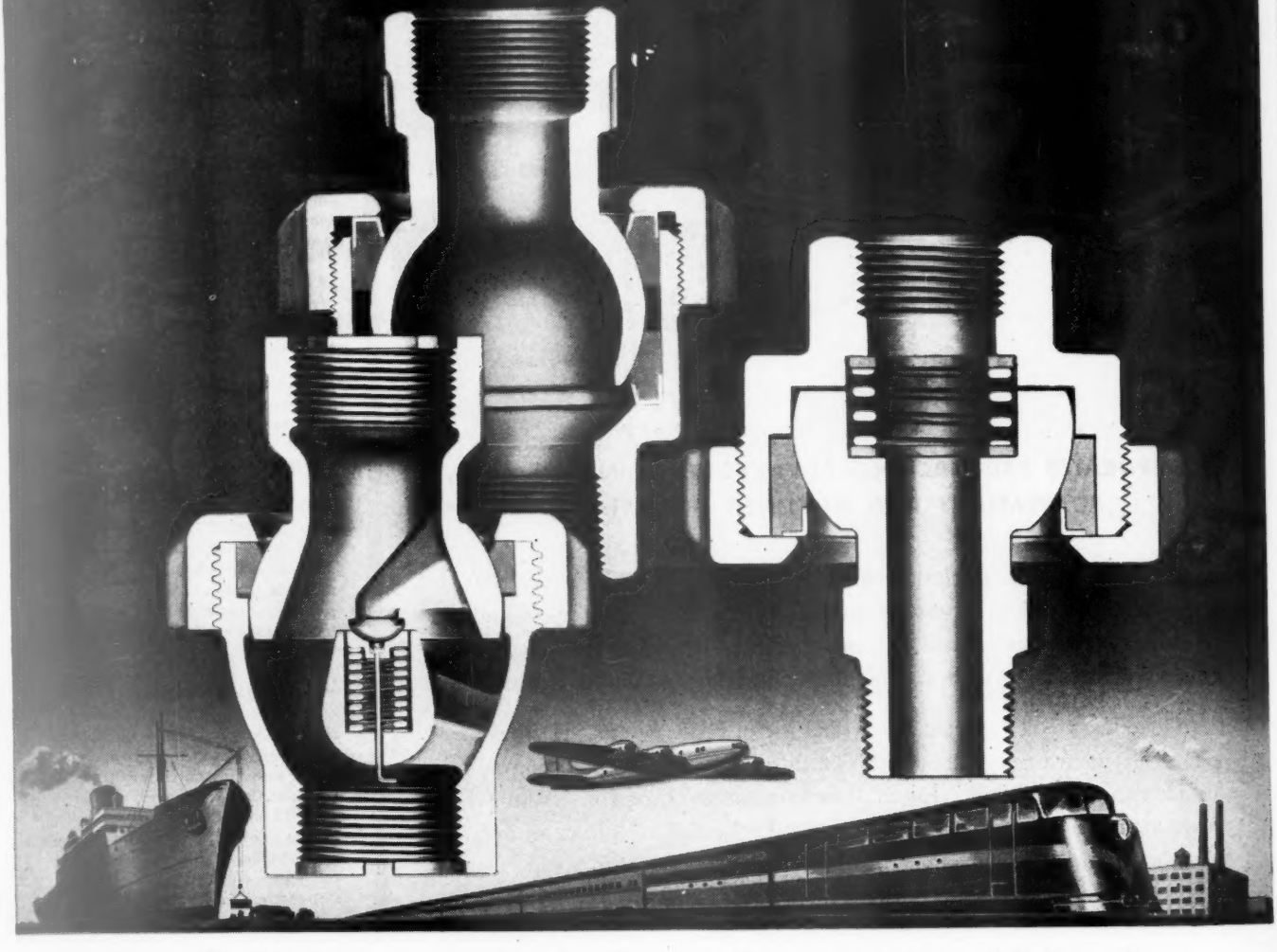
• ***Constant Radiation*** **at all times is another important advancement. The source of radiation is a photo electronically stabilized Nernst lamp which insures constant radiation regardless of line voltage fluctuations.**

• ***Hermetically Sealed,*** **the optical path is free of CO_2 and water vapor. Two-stage drying protects precision optical elements.**

These are only a few of the improvements incorporated in this new Beckman development but they are typical of many unusual features to be found in the IR-2 that make this the most advanced Spectrophotometer available.

FLEXIBLE FLUID CONVEYORS

ABSORB VIBRATION—PROVIDE MOVEMENT

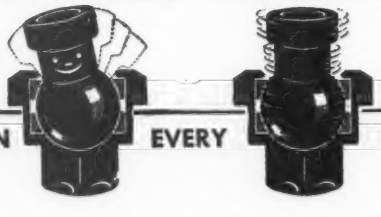


Barco Flexible Joints are serving in all industries where flexible conveyors are required for oil, steam, water, air, gas, etc. By means of responsive movement, Barco joints compensate for every motion —literally "roll with the punch" to absorb vibration, provide smooth movement. For over 30 years, engineers and designers have found in Barco's wide range of designs the solution to their flexible joint problems. Consult our engineering department for detailed information. Barco Manufacturing Co., Not Inc., 1825 Winnemac Avenue, Chicago 40, Illinois.

In Canada: The Holden Co., Ltd., Montreal, Canada

BARCO **FLEXIBLE JOINTS**

MANUFACTURING CO., NOT INC. 1800 Winnemac Ave., CHICAGO 40, ILL.

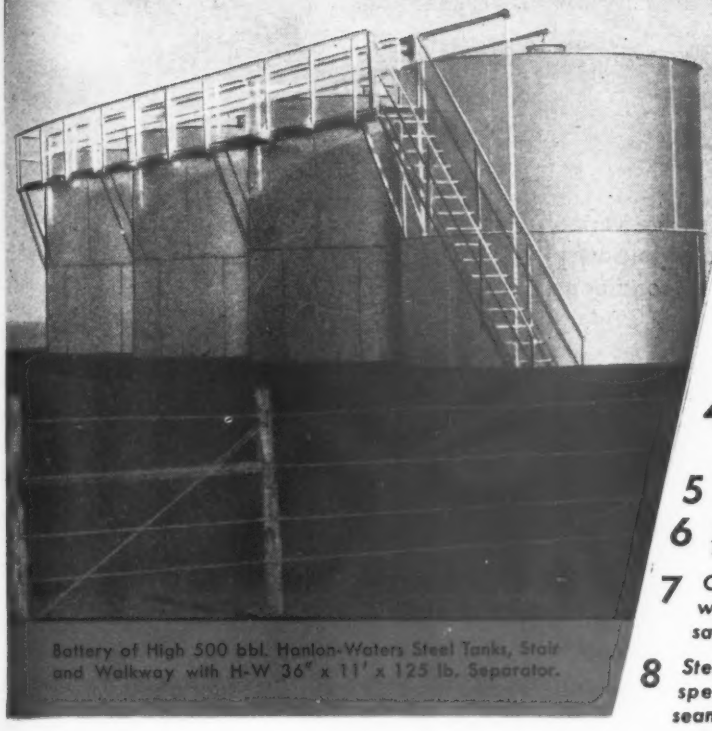


Not just a swivel joint...but a combination of a swivel and ball joint with rotary motion and responsive movement through every angle.

THE FREE ENTERPRISE SYSTEM IS THE SALVATION OF AMERICAN BUSINESS

"MOVE IN EVERY DIRECTION"

Tanks that can "*Take it*"



Battery of High 500 bbl. Hanlon-Waters Steel Tanks, Stair and Walkway with H-W 36" x 11' x 125 lb. Separator.

CONSTRUCTION FEATURES

1. *Sturdy, heavy gauge segmental decks and bottoms.*
2. *Extra heavy steel angle rafters reinforced with steel channels or truss-type cantilever construction.*
3. *Extra strong heat-treated bolts—heads will not twist off.*
4. *Copper steel (highly rust resistant) or <u>double</u> hot-dipped galvanized for extra durability.*
5. *Large clean-out plate.*
6. *Aluminum non-spark Valve and Thief Hatch.*
7. *Cantilever type, self supporting Stairways and Walkways with non-skid safety tread.*
8. *Steel channel reinforced seams with special rubber packing for tight seams and joints.*

HANLON-WATERS

Precision-built, Bolted Steel Tanks—by their longer life and lower maintenance—CUT OIL STORAGE COSTS!

AT ALL seams, bottom, side and deck, and at all joints—H-W Bolted Steel Tanks have a built-in *extra* margin of strength.

Beginning with high grade, Blue Annealed Copper Steel (plain or galvanized) possessing 200% to 500% greater resistance to rust and corrosion than ordinary sheet steels, Hanlon-Waters Bolted Steel Tanks are built with extra construction features to withstand—for long years of trouble-free service—the severe strains and stresses common in oil field use.

Rafters and seams are steel-channel reinforced. Bolts and nuts are specially heat treated by Lamson & Sessions process for 95,000 to 100,000 pounds tensile strength. Heads cannot twist off, threads will not strip. Ladders are of extra heavy angle steel construction to support decks. Packing is especially resilient, pliable and durable.

Specifications throughout are rigid API Standard. 12 sizes: 100 to 10,000 barrel capacity. 500 to 1,000 barrel sizes available in either low or double stave type.

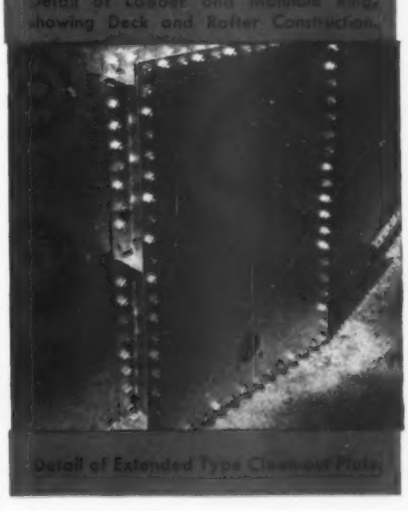
☆

For complete construction details, prices, etc., write for Hanlon-Waters Tank Bulletin No. 112. Write Hanlon-Waters, 15 N. Cincinnati St., Tulsa, Okla. *Affiliated with Climax Engineering Co., Clinton, Ia.; McAlear Manufacturing Co., Chicago.*

WAREHOUSE STOCK POINTS • *Texas:* Corpus Christi, Houston, Odessa, Wichita Falls. *Louisiana:* Houma, Shreveport. *Oklahoma:* Tulsa.

Photo of Segmental Tank Bottom Construction, Note the "Joint" gasket used at the chime joint.

Detail of Ladder and Manhole Ring, showing Deck and Rafter Construction.



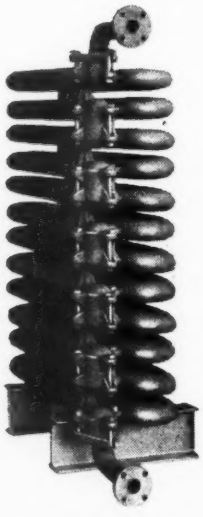
Detail of Extended Type Clean-out Plate.

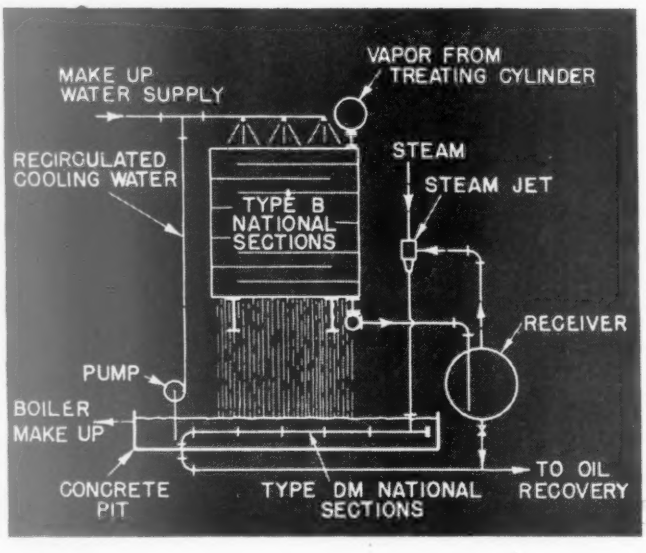
H-W
WELDED TANKS
BOLTED TANKS
SEPARATORS

McALEAR
PRESSURE · FLOW · LIQUID LEVEL · TEMPERATURE
controls
for STEAM, WATER, AIR, OIL or GAS

NATIONAL CONDENSING and COOLING SECTIONS are EFFICIENT and FLEXIBLE

The sectional design of National Sections plus the variety of types available permits their application to widely varying services and easy alteration to changed conditions.





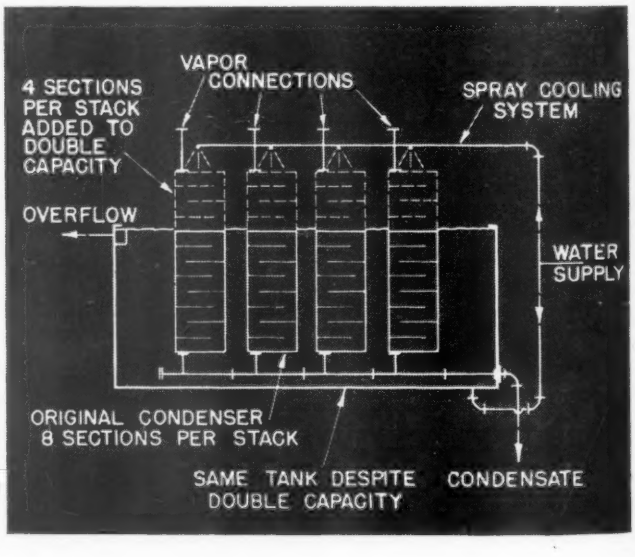
CREOSOTE OIL-STEAM CONDENSER

At left is illustrated one of several National Section installations in wood preserving plants. Creosote oil vapor is pulled over from the treating tank and the condensate is recovered in the separating receiver. The remaining vapors and ejector eflux are condensed in the submerged after-condenser which serves as a tempering coil for boiler make-up. The water which is sprayed on the main condenser is also used for boiler feed and recirculation can be used to maintain proper temperatures.

LIGHT OIL CONDENSER CAPACITY DOUBLED

When the capacity of a light oil recovery plant was doubled, the owner contemplated duplicating the existing National Section submerged type condenser. National engineers recommended merely adding to the height of each existing stack and spraying those sections above the water line. This eliminated new foundations and structural work and saved badly needed space. The higher efficiency of sprayed sections reduced the required additional surface to 50% of the original.

For further information write to



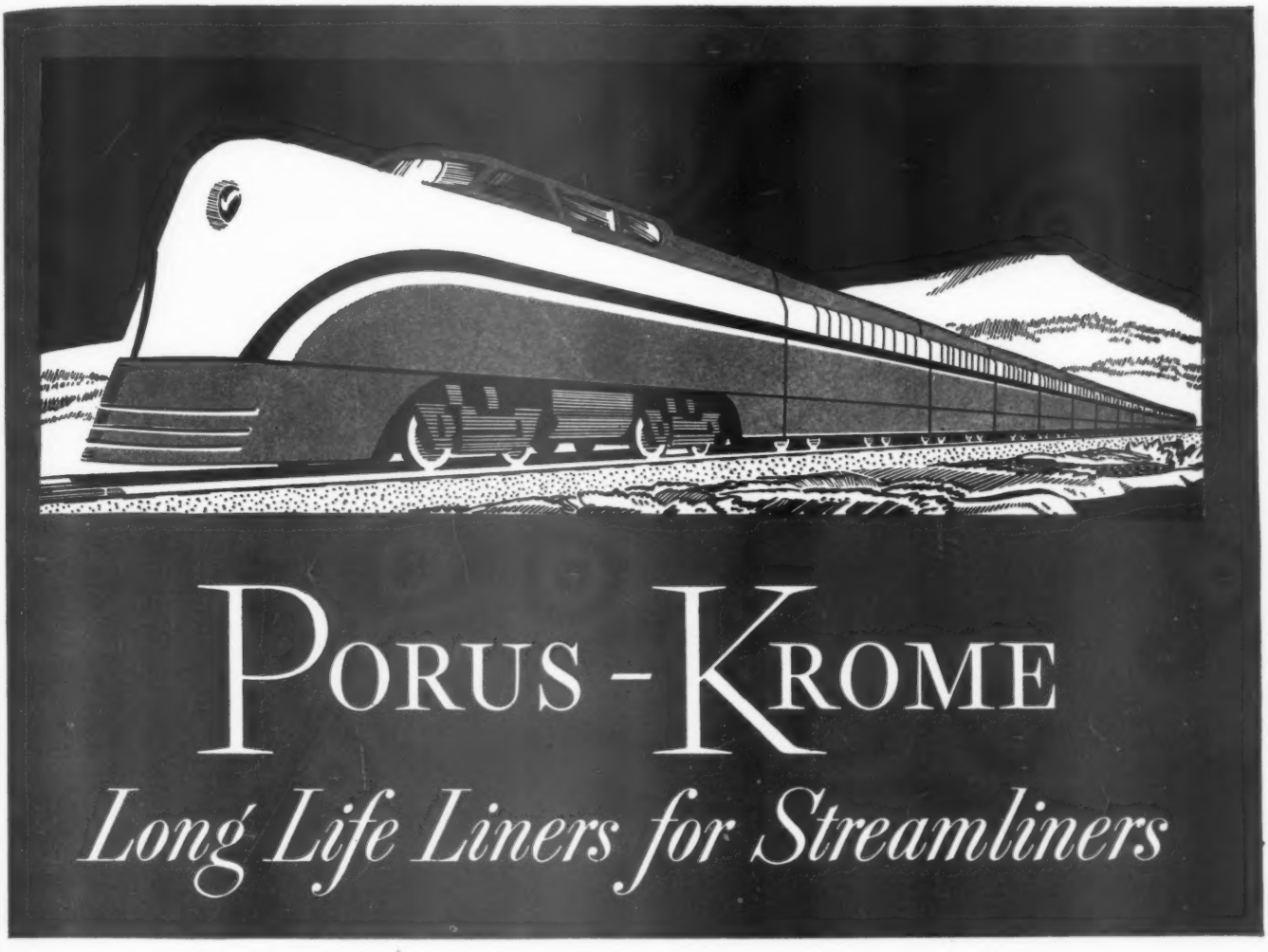
INDUSTRIAL DIVISION

The NATIONAL RADIATOR Co.

227 Central Avenue · Johnstown, Pa.

ESTABLISHED OVER 50 YEARS

The Maritime "M" Award For "Outstanding Production Achievement"



PORUS-KROME

Long Life Liners for Streamliners

Sleek, powerful and modern though the Streamliners are, there is a spot that is vulnerable to wear . . . the cylinder liners and rings of their rugged Diesel engines. Or rather, the liners are vulnerable to wear *unless they are long life liners treated with* PORUS-KROME, which reduces wear and multiplies the life of the liners and rings.

That is why one large manufacturer of Diesel engines for Streamliners and other applications has standardized on PORUS-KROME liners for all engines coming off the production line. And that is why other engine manufacturers are planning to use PORUS-KROME in their engines as soon as they can again build engines for civilian use. It enables them to offer their customers engines of greater reliability and longer life . . . and lower maintenance costs.

And what is PORUS-KROME?

PORUS-KROME is hard, pure chromium which is applied to cylinder bores by the patented Van der Horst process. It has tiny pores and channels in its surface which serve as reservoirs for lubricating oil, feeding it back to the surface as needed. It reduces corrosion and wear and multiplies cylinder life 4 to 20 times, and ring life 3 to 4 times.

If you want engines of greater reliability and lower maintenance costs, write today for detailed description of PORUS-KROME and how you can get its advantages in your engines.

PORUS - KROME

Good for the Life of your Engines

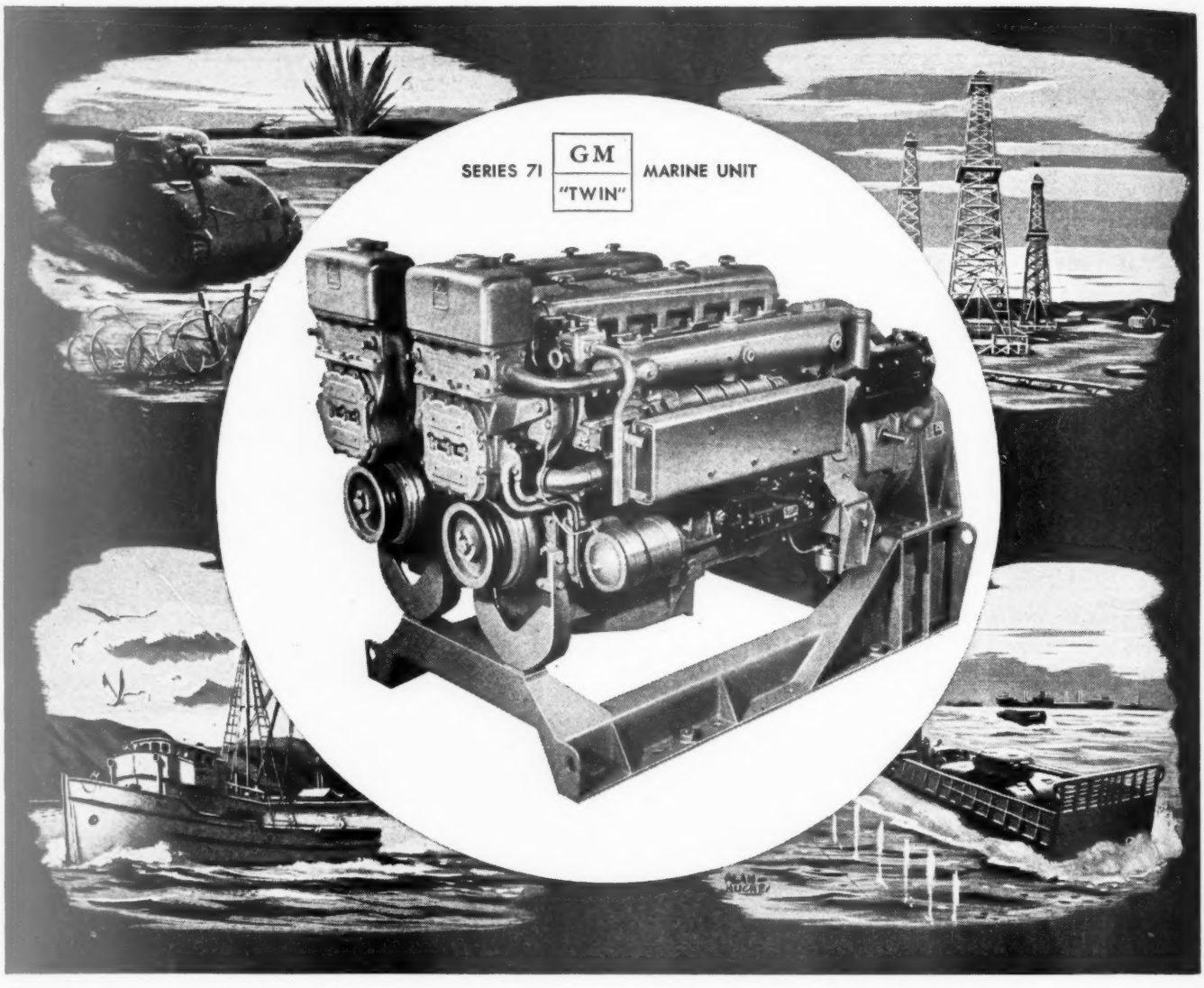
VAN DER HORST

U. S. PATENTS 2,046,570 AND 2,314,004

VAN DER HORST CORPORATION OF AMERICA

AN AFFILIATE OF DRESSER INDUSTRIES

OLEAN • NEW YORK
CLEVELAND 11 • OHIO



SAVING BOTH SPACE AND WEIGHT

This is a pair of General Motors series 71 Diesel engines built side by side, delivering their power through a single shaft. It is Detroit Diesel engineers' answer to an urgent call for a lot of dependable Diesel power in a small space.

Some of the jobs assigned the basic series 71 power units in "Singles," "Twins," and "Quads" are among the toughest on the books today—powering landing craft and driving Army M-3, M-4 tanks and M-10 tank destroyers.

It takes "oomph"—plenty of it—to plow a tank through hip-deep mud, to lift it out of shell craters, to keep it hot after the enemy—to beach and extricate a landing craft when the breakers are running high.

So it is easy to look ahead and see how these "multiple" Diesels will take hold of the countless jobs of industry and perform them equally well—particularly where the ratio of power to weight or space is of prime importance.

And remember, these "Twins" and "Quads," like the single sixes, share all the important developments which General Motors has contributed to Diesel science.

KEEP AMERICA STRONG
BUY MORE WAR BONDS

GM
GENERAL MOTORS
DIESEL POWER

ENGINES . . 15 to 250 H. P. . . DETROIT DIESEL ENGINE DIVISION, Detroit 23, Mich.

ENGINES . . 150 to 2000 H. P. . . . CLEVELAND DIESEL ENGINE DIVISION, Cleveland 11, Ohio

LOCOMOTIVES . . . . . ELECTRO-MOTIVE DIVISION, La Grange, Ill.

MORE FEET OF HOLE . . .
MORE HOLE PER DOLLAR

with new IDECO Streamlined Rotaries

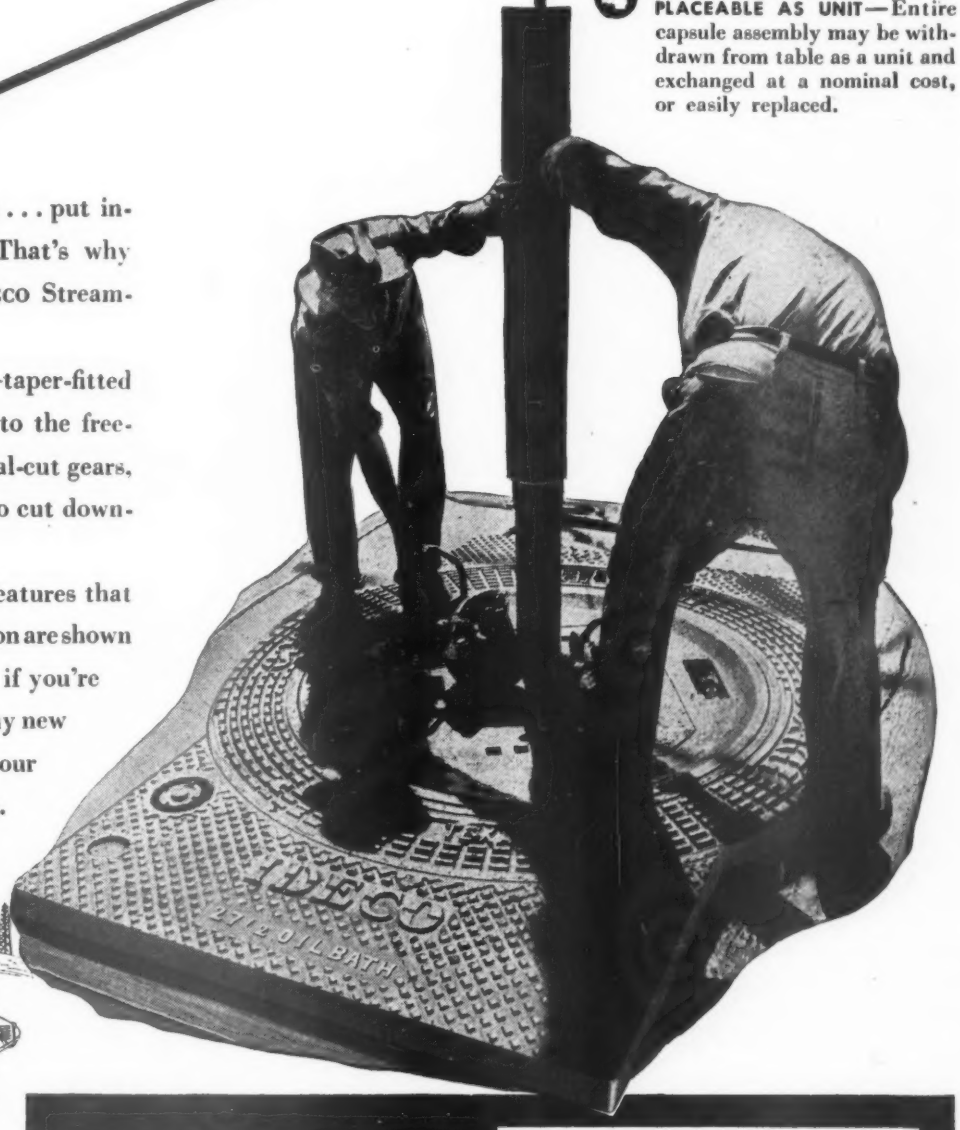
HERE'S WHY:

1. **JUST ONE PLACE TO LUBRICATE**—Every moving part, including pinion assembly, works in a bath of oil. No "missed" lubrication points to cause trouble.
2. **POSITIVE, SAFER TABLE LOCK**—Locking bar engages notches in table skirt, relieving stresses on pinion shaft, gears and bearings.
3. **DOUBLE STANDING SURFACE PROTECTS CREW**—Smooth box shape gives twice the standing room around hole—prevents stumbling and slipping accidents.
4. **PINION ASSEMBLY EASILY REPLACEABLE AS UNIT**—Entire capsule assembly may be withdrawn from table as a unit and exchanged at a nominal cost, or easily replaced.

Deeper drilling . . . faster speeds . . . put increasing demands on rotaries. That's why operators welcome the new IDECO Streamlined Rotary Table.

From the new drive sprocket—taper-fitted to the shaft for easy removal—to the free-running table with its quiet, spiral-cut gears, these IDECO units are designed to cut down-time to a minimum.

Some of the exclusive IDECO features that assure longer, trouble-free operation are shown here. You'll want the full details if you're planning to replace old units or buy new ones. Ask for new booklet at your nearest IDECO store or sales office.



EVERYTHING FOR OIL DRILLING AND PRODUCTION FROM ONE CONVENIENT SOURCE

The Streamlined Rotary represents just one of many IDECO-engineered developments for the drilling and production industry. Supplemented by a complete line of oilfield supplies available through IDECO stores, they provide a single responsible source for equipment, supplies and service.

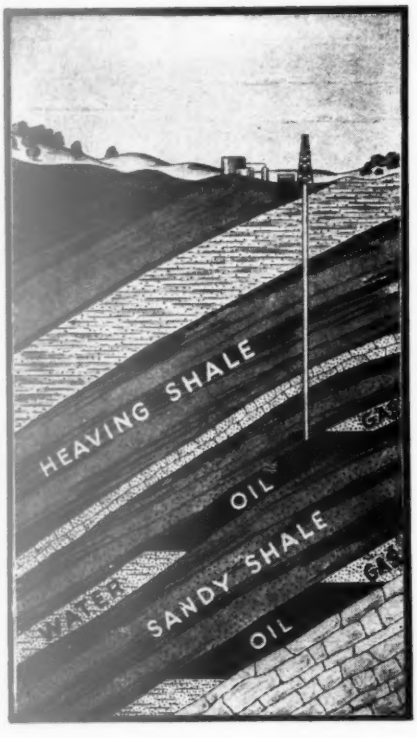
IDECO

ONE OF THE DRESSER INDUSTRIES

INTERNATIONAL DERRICK & EQUIPMENT COMPANY

REGIONAL SALES OFFICES: Columbus 8, Ohio; Dallas 1, Texas; Los Angeles 13, Calif...EXPORT: 122 East 42nd St., New York 17, N. Y...SALES OFFICES AND STORES in all active oil fields.

Nature's *Self-Sealing* Oil Tank



Heaving shale can completely wreck drilling operations unless controlled by this effective method.

LIKE the self sealing layers around a bullet proof gasoline tank, heaving shales above an oil formation may "self seal" the oil deposits beneath to the extent of making them undrillable by ordinary methods.

Made unstable by hydration such shales ordinarily swell and slough into the well bore so as to force abandonment of the well, often with loss of part of the drill stem and sometimes the lower part of the casing string.

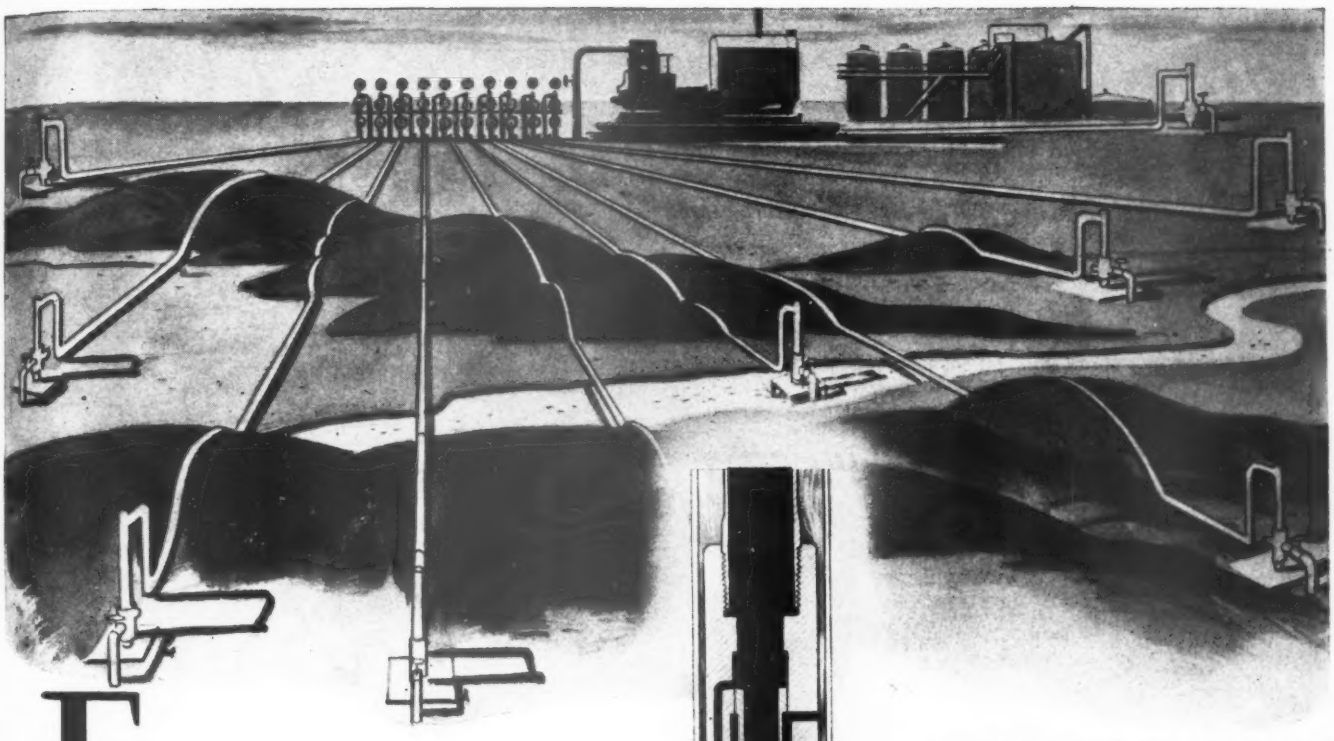
The sodium silicate method of heaving shale control, developed by Texaco, checks this hydration, keeps the shale stable and permits penetration of heaving shale and exploration and development of sands and oil below.

It is now being used by many major oil companies in the Gulf Coast area.

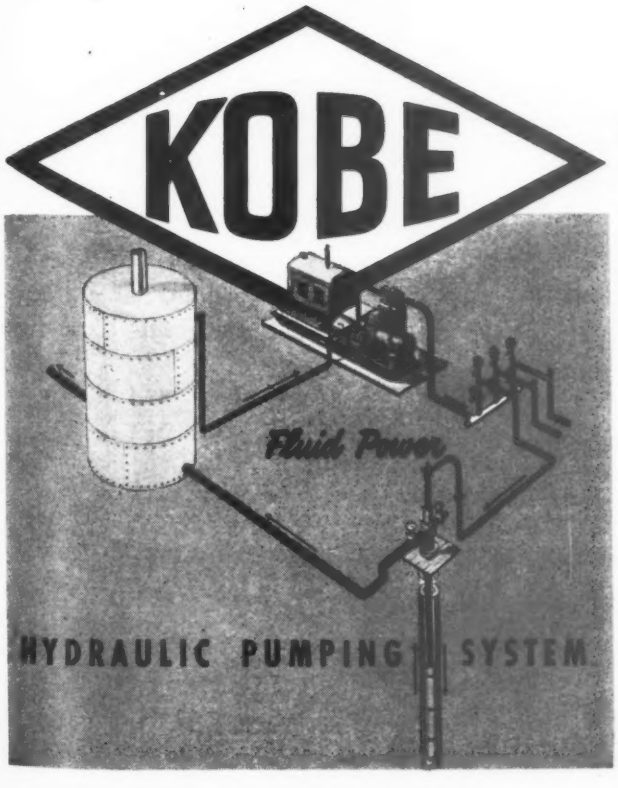
TEXACO

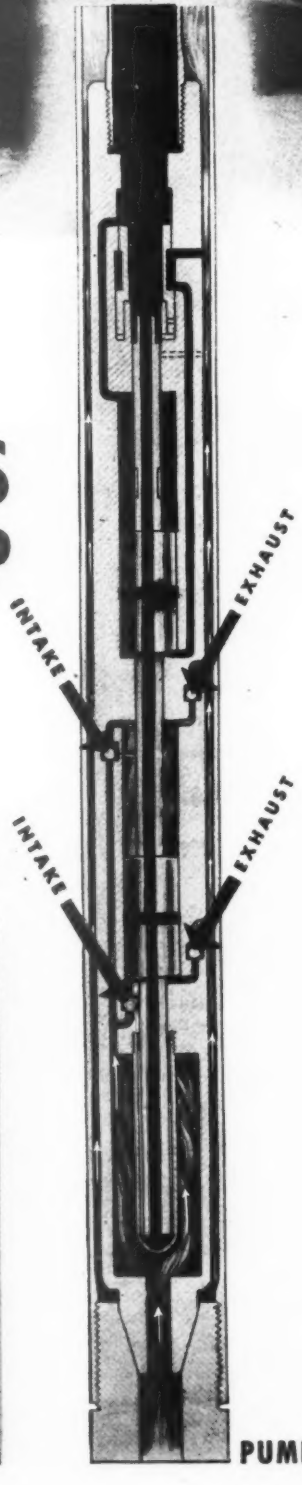
TEXACO DEVELOPMENT CORPORATION

A Subsidiary of The Texas Company



Every STROKE COUNTS WHEN YOU PUMP WITH KOBE





KOBE pumping delivers more oil in the tank per horsepower used because the Kobe System produces oil at every stroke of the pump — *up* or *down*.

This is an exclusive Kobe feature that *can't be copied*, because only Kobe uses hydraulic power and hydraulic power is the *only* practical known means by which energy can be applied directly to an engine pump at the bottom of an oil well to actuate it for duo-directional pumping. The Kobe pump has hydraulic intake and exhaust valves at each end, allowing pump action on each piston stroke.

Translated into pumping efficiency, or just plain barrels per horsepower input, Kobe "fluid power" sets a brand new standard. It isn't just a little more efficient. It is by far the most efficient pumping system so far devised to bring crude oil to the surface of the earth.

No other form of motive power used for pumping can produce as much oil as Kobe "fluid power" in relation to the amount of power applied. Kobe and only Kobe can make this statement.

Call in your nearest Kobe representative *today* to illustrate the dollars and cents savings possible through Kobe's greater pumping efficiency.

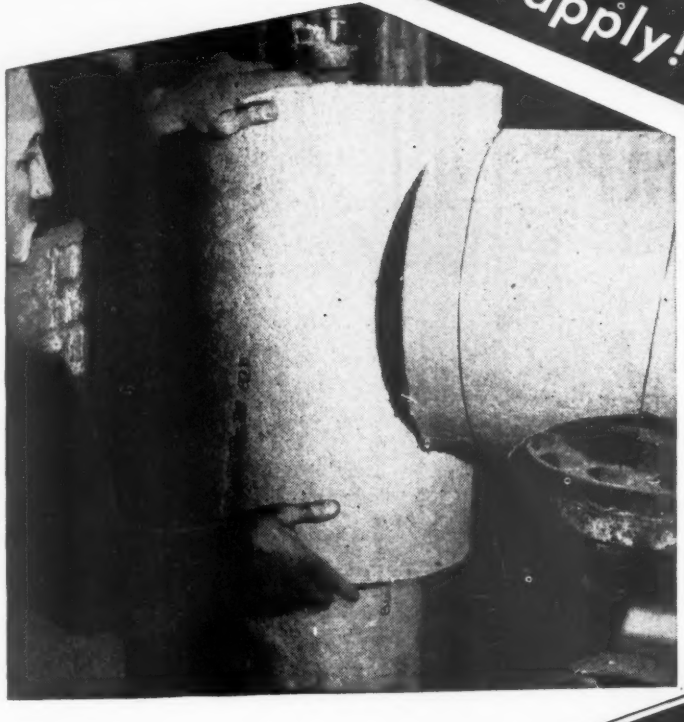
KOBE, Incorporated. *General Offices & Plant: 3040 East Slauson Ave., Huntington Park, Calif. • Mid-Continent Division Offices and Shops: 230 S. E. 29th St., Oklahoma City, Okla. • California Division Offices: 217 Wilson Bldg., Huntington Park, California • Export Agent: Petroleum Machinery Corporation, 30 Rockefeller Plaza, New York, N. Y.*

PUMP THE MODERN WAY-USE KOBE

GETTING "HOT UNDER THE COLLAR"?

SIMPLY APPLY UNIBESTOS

it's simple to apply!



It's easy to cover flanges and fittings with Unibestos, the sectional insulation. Unibestos saws or cuts clean and sharp with ordinary tools—no mess. Here's how it's done: bring adjacent pipe covering up to proper level by use of a collar of a standard section of Unibestos and then simply span both flanges with a single piece of sectional Unibestos properly cut to fit. That's all there is to it! . . . and you have a smooth, neat, efficient and readily-removable installation.

UNION ASBESTOS
MEANS PROGRESS IN INSULATION
AND RUBBER CO.

ARMY E NAVY

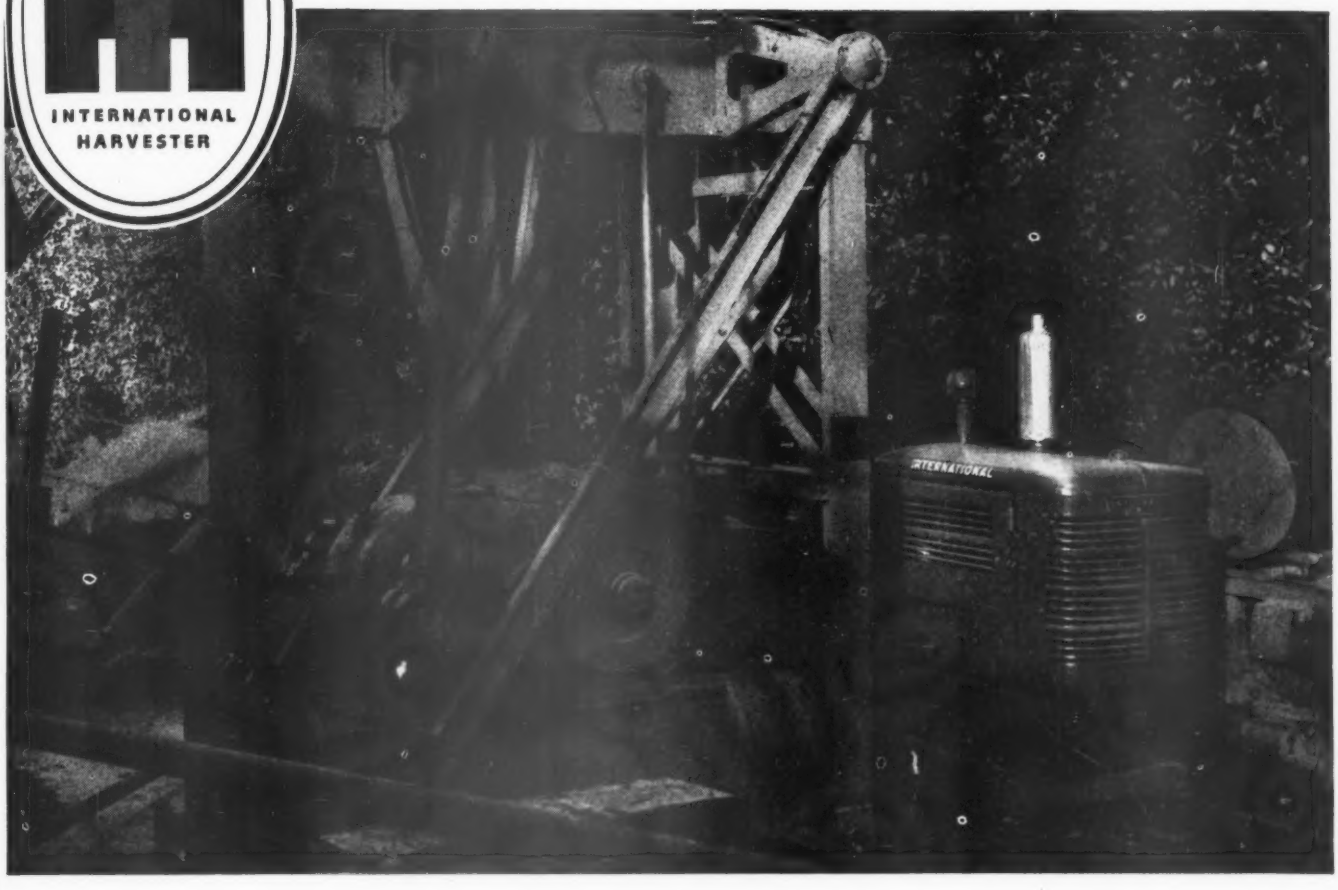
PLANTS: 1821 S. 54th Ave., CICERO, ILL. • PATERSON, N. J. • BLUE ISLAND, ILL.
OFFICES: CHICAGO • CICERO, ILL. • NEW YORK • SAN FRANCISCO • PATERSON, N. J.

COPYRIGHT 1944
UNION ASBESTOS AND RUBBER CO.

THIS SYMBOL MEANS—

"Product of INTERNATIONAL HARVESTER"

INTERNATIONAL HARVESTER



It Is the Mark of EXPERIENCE *and* SERVICE

INTERNATIONAL HARVESTER is proud that all its peacetime products are vital, basic, and *essential*—even in a national economy geared to war.

In these war years Harvester has also built millions of strange new precision machines that are purely implements of war. These we shall build so long as there is need.

There will be an end to them when war is over.

But for the things that are traditionally Harvester's, there will be *a new beginning.*

International Engines, TracTracTors and Wheel Tractors will play a major part in the making of the Post-War world. As all of these are fighting, now, on battlefront and home front, they will fight to insure a greater future for America.

Let THIS MARK—the symbol displayed here—be your guide when you have need for products such as these that Harvester builds.

It is a new mark for an old name, known to all the world—INTERNATIONAL HARVESTER.

It is the symbol of a reputation which shall rise to whatever heights the united people of America may choose to reach in their own march to the future.

This you may take as Harvester's pledge to the oil industry.

INTERNATIONAL HARVESTER COMPANY
180 North Michigan Ave. Chicago 1, Illinois

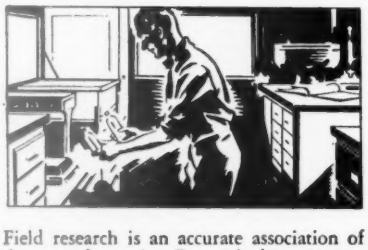
HARVESTER

BUY MORE WAR BONDS AND KEEP THEM!

INTERNATIONAL HARVESTER
Power for Victory . . . Power for Peace

Tret-O-lite research technicians carry on a continuous program to develop the most economical and effective dehydrating compounds.

In the completely equipped mobile labs, field research can be carried on with exacting laboratory precision.



Field research is an accurate association of theory and practice. Research data accumulated in the field labs is important to the entire research program.

Complete Service for Every Field

SINCE all crude oil and water emulsions do not respond to the same treating methods and chemical compounds, effective dehydration is dependent upon continuous research. To assure Tret-O-lite users maximum compound efficiency, the Tretolite Company has carried on such a program for many years.

One important phase of Tret-O-lite Research is the mobile field research equipment. These supplements to the extensive Tret-O-lite laboratory division can be moved right out into the field there to gather important data for the Tret-O-lite research program. The activities of the mobile labs today result in better treating compounds tomorrow. This field research is just another graphic proof of Tret-O-lite's leadership.

TRETOLITE COMPANY
Manufacturing Chemists
WEBSTER GROVES, ST. LOUIS COUNTY, MO.
LOS ANGELES, CALIF.

Oil is Ammunition • Treat it Right

Tret-O-lite
REG. U. S. PAT. OFF.

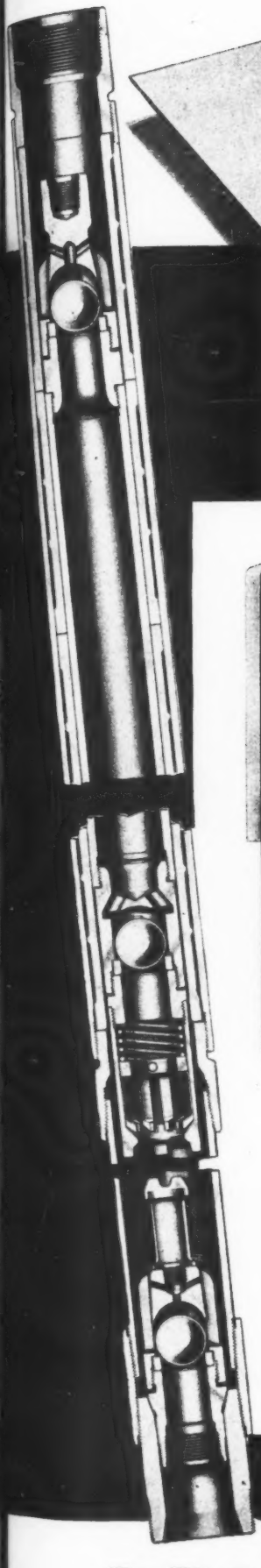
DEHYDRATING **DESALTING**

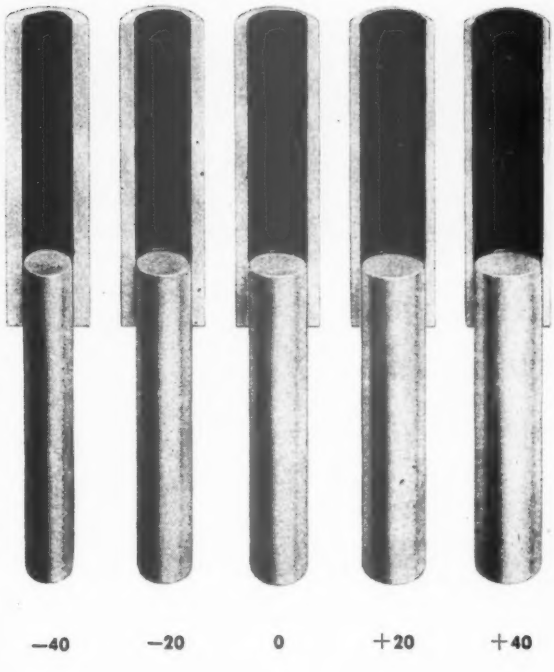
COMPLETE SERVICE FOR EVERY FIELD

PACIFIC PRECISION PUMP

REGRINDING — REFITTING — RECONDITIONING

Service

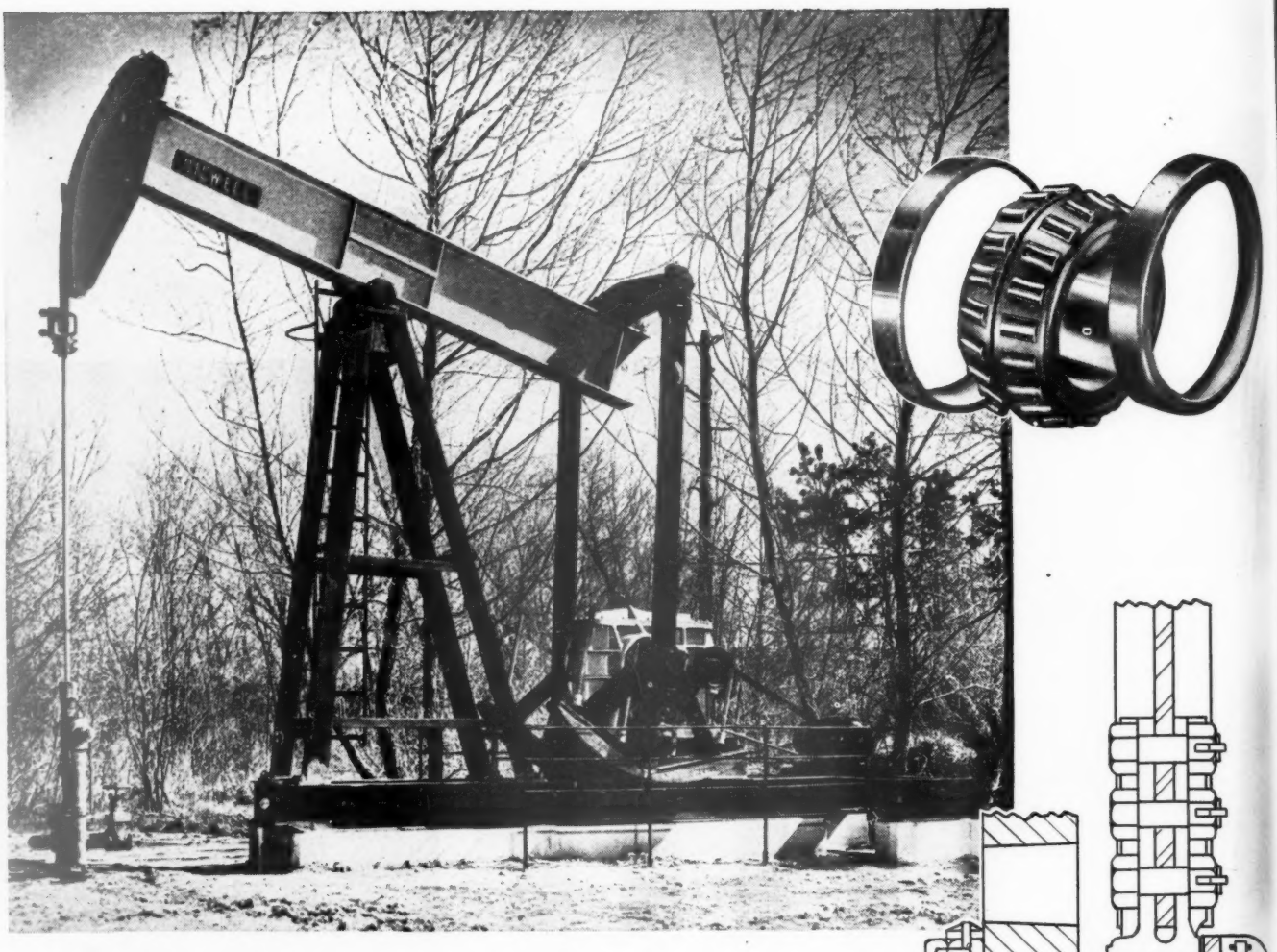


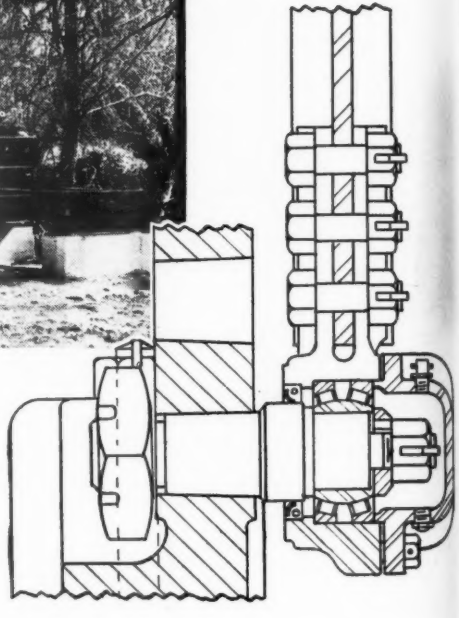


PACIFIC LINERS AND PLUNGERS CAN BE REGROUND 3 TO 4 TIMES

By special processes, Pacific Pumps can be completely reconditioned four to five times. Liners are ground up, Plungers ground down, then refitted with split-hair precision. Result—you have a new pump at only a moderate service cost. You cut your per barrel pumping expense proportionately.

PACIFIC *Engineered* PUMPS





LINK-BELT Self-Aligning Roller Bearings Help Equalize Pitman Loading

MORE than 25,000 load reversals are handled in a single day in pumping unit wrist pin service (at 18 s.p.m.) . . . which tells the story of bearing dependability required in this type of application.

The unitized pitmans on Oil Well Supply Company's Twin-Crank Pumping Units, like the TC-23 Unit pictured above, are equipped with Link-Belt self-aligning grease-packed wrist-pin roller bearings of the twin-row, concave roller type (note top inset) enclosed in weather-proof one-piece steel housings. Cross-sectional drawing shows a typical "Oilwell" wrist-pin installation. The self-aligning feature of these bearings contributes to the complete equalization of pitman loading on these units and, combined with "Oilwell's" knuckle-joint pitman construction, makes changing stroke lengths an easy one-man job.

Pumping unit service is one of the many oil industry applications where Link-Belt self-aligning roller bearings are assuring trouble-free bearing service indefinitely. Well known for their ability to take either radial or thrust loads or a combination of both, they are available in unmounted sizes or mounted units . . . in pillow blocks, hangers, flanged or take-up mountings. Data Book No. 1775-A supplies full engineering and application data. Write for it today.

LINK-BELT BALL AND ROLLER BEARINGS

LINK-BELT COMPANY

Indianapolis 6, Dallas 1, Houston 2, Kansas City 6, Mo., Los Angeles 33, New York 7, Toronto 8. Offices, factory branch stores and distributors in principal cities. 9016

Designed TO WORK MORE EASILY—
Built TO LAST LONGER—

ASBESTOS-PACKED COCKS

READING-PRATT & CADY

That, in brief, is the story of this double gland Asbestos-Packed Cock—a **READING-PRATT & CADY** "original."

This cock serves best as a shut-off on lines that carry solids in suspension—viscous fluids—oils—acids and alkalis—steam (for boiler blow-off)—in short, wherever Globe, Angle or Gate valves fail or where conventional ground plug cocks prove unsatisfactory. It is made in cast iron, bronze and cast steel.

U-shaped grooves in the body of this cock are packed solidly with asbestos, which is then vulcanized. This provides a bearing which absorbs expansion and eases operation. The double gland feature—independently controlled pressure on plug and top packing—still further eases operation and prolongs life.

R-P & C offers you a single responsible source for bronze, iron and steel gate, globe, angle and check valves—cocks and lubrotite gate valves—bar stock valves—cast steel fittings—D'Este Automatic Valves and Engineering Specialties.

READING-PRATT & CADY

MANUFACTURERS OF

READING CAST STEEL VALVES AND FITTINGS • PRATT & CADY BRASS AND IRON VALVES
D'ESTE VALVE AND ENGINEERING SPECIALTIES

Reading, Pa. • Atlanta • Boston • Chicago • Denver • Houston • Los Angeles • New York • Philadelphia • Pittsburgh • San Francisco • Bridgeport, Conn.

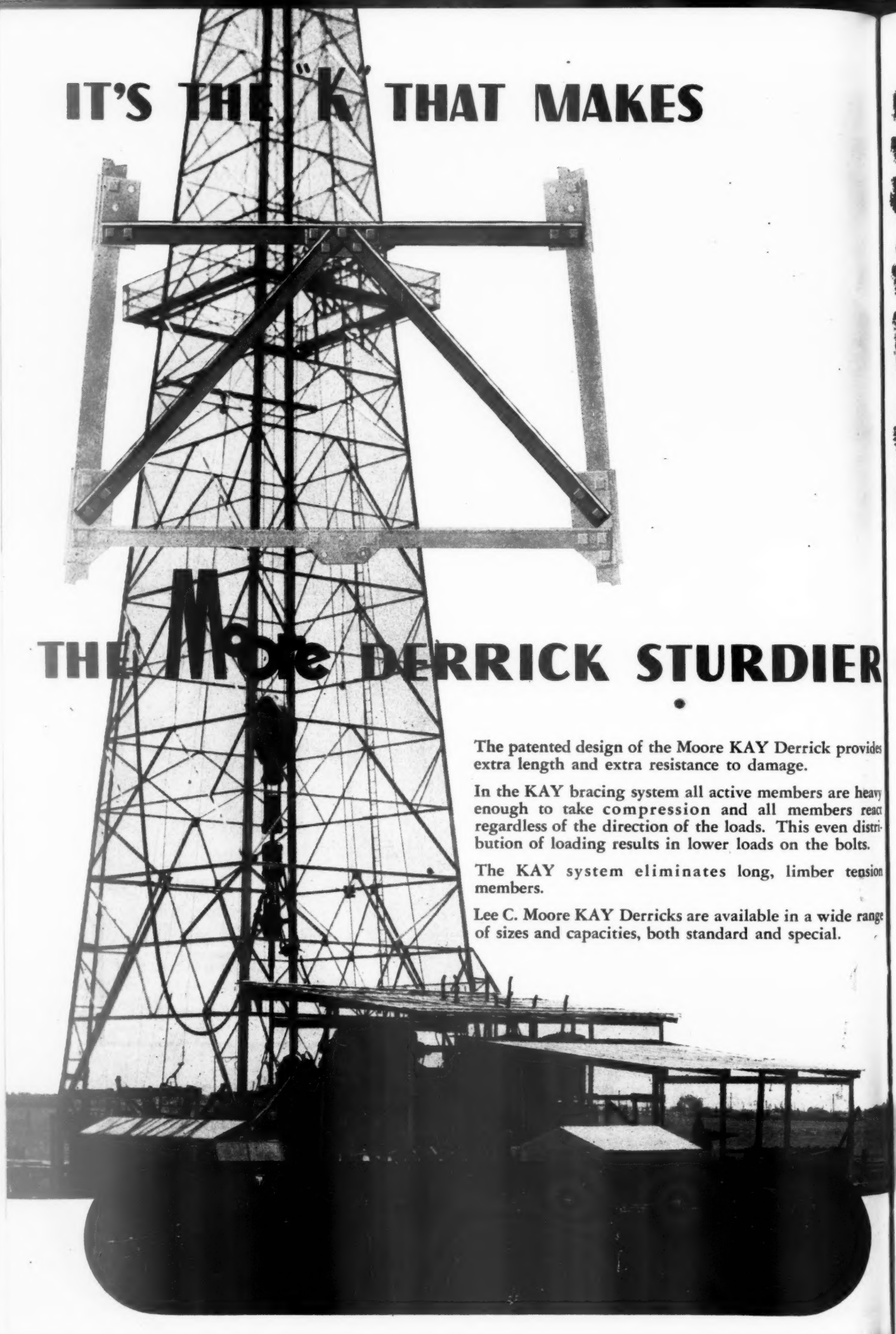
READING-PRATT & CADY DIVISION
AMERICAN CHAIN & CABLE

ACCO

TRADE MARK

In Business for Your Safety

IT'S THE "K" THAT MAKES THE Moore DERRICK STURDIER



The patented design of the Moore KAY Derrick provides extra length and extra resistance to damage.

In the KAY bracing system all active members are heavy enough to take compression and all members react regardless of the direction of the loads. This even distribution of loading results in lower loads on the bolts.

The KAY system eliminates long, limber tension members.

Lee C. Moore KAY Derricks are available in a wide range of sizes and capacities, both standard and special.

. . . . and ONLY MIDWEST offers THIS CHOICE

Before you select welding elbows to use on any given piping job, it will be worth your while to consider the relative values of the two elbows shown. On some jobs the correct selection can mean a real saving of time and money. Only Midwest offers you the choice of either type elbow . . . and there is no difference in price.

The "American Standard" elbow has a center-to-end dimension equal to one and one-half times the nominal pipe size. The Midwest "Long Tangent" elbow has a center-to-end dimension of one and three-quarters times the nominal pipe size; it has tangents (straight ends) equal to one-fourth of the nominal pipe size.

These long tangents make it possible for pipe and fitting to be lined up more quickly and accurately. Less pipe is required, a short nipple and an extra circumferential weld are frequently eliminated, and slip-on welding flanges are more easily used.

Both elbows have all advantages of the unique Midwest manufacturing process: final working of the metal in compression (which means exceptional dimensional accuracy and uniformity), stress relieving, exact included angle, true circular section and uniform wall thickness.

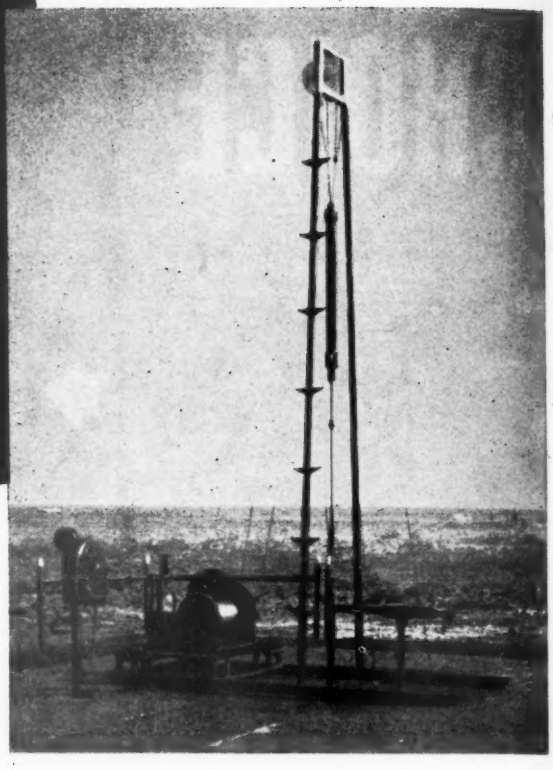
MIDWEST

PIPING & SUPPLY COMPANY, INC.

Main Office: 1450 South Second St., St. Louis 4, Mo.

Sales Offices: New York—(Eastern Division) 30 Church Street
Chicago—645 Marquette Bldg. • Los Angeles—520 Anderson Street
Houston—229 Shell Bldg. • Tulsa—533 Mayo Bldg. • South Boston—
426 First St. • Atlanta—Red Rock Bldg. • Distributors in Many Cities

MORE OIL and MORE PROFIT per barrel



There has seldom been a time in the oil industry where profit depended so much on economical operation as right now.

That is why the Nixon Gas Lift has forged to the front so fast—it produces the oil, after other methods fail—and it does it at less cost per barrel.

And that's but half the story—the Nixon Gas Lift costs less for initial installation and maintenance costs are almost zero. Truly—the Nixon Gas Lift is the modern way of producing oil.

Contact your nearest Wilson Supply Company store or sales office for complete information on the Nixon Gas Lift—they are available NOW.

MORE THAN 3000 IN THE FIELD

The Nixon Gas Lift is not an untried, unproven, complicated theory—just the opposite. There are today more than 3000 of them installed in the oil fields—doing everything claimed for them—and more.

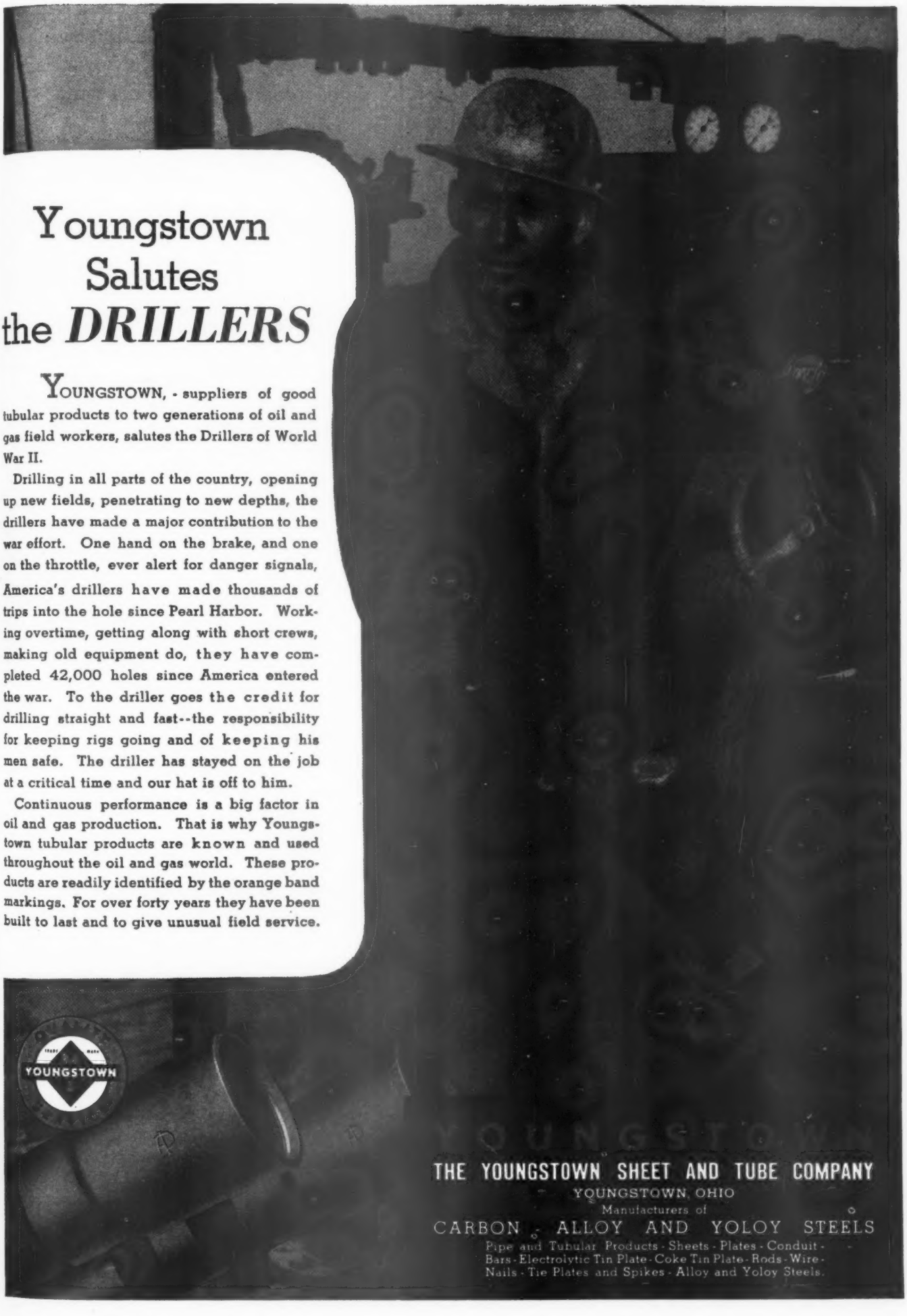
International Distributors of Nixon Gas Lifts and Nixon Regulators

WILSON SUPPLY CO.

1412 MAURY ST., HOUSTON, TEXAS

SALES OFFICES: Tulsa, Oklahoma; Dallas and Beaumont, Texas. LOS ANGELES: Western Pressure Control, 5700 Santa Fe Ave. TRINIDAD, B.W.I.: Neal Massey Eng. Corp.

BRANCH STORES: TEXAS—Gladewater, Barbers Hill, Bay City, Monahans, Alice, Victoria, Corpus Christi. LOUISIANA — Lake Charles, New Iberia, Harvey, Shreveport. ARKANSAS—Magnolia. MISSISSIPPI—Natchez.



Youngstown Salutes the *DRILLERS*

YOUNGSTOWN, - suppliers of good tubular products to two generations of oil and gas field workers, salutes the Drillers of World War II.

Drilling in all parts of the country, opening up new fields, penetrating to new depths, the drillers have made a major contribution to the war effort. One hand on the brake, and one on the throttle, ever alert for danger signals, America's drillers have made thousands of trips into the hole since Pearl Harbor. Working overtime, getting along with short crews, making old equipment do, they have completed 42,000 holes since America entered the war. To the driller goes the credit for drilling straight and fast--the responsibility for keeping rigs going and of keeping his men safe. The driller has stayed on the job at a critical time and our hat is off to him.

Continuous performance is a big factor in oil and gas production. That is why Youngstown tubular products are known and used throughout the oil and gas world. These products are readily identified by the orange band markings. For over forty years they have been built to last and to give unusual field service.

YOUNGSTOWN

THE YOUNGSTOWN SHEET AND TUBE COMPANY

YOUNGSTOWN, OHIO

Manufacturers of

CARBON - ALLOY AND YOLOY STEELS

Pipe and Tubular Products - Sheets - Plates - Conduit - Bars - Electrolytic Tin Plate - Coke Tin Plate - Rods - Wire - Nails - Tie Plates and Spikes - Alloy and Yoloy Steels.

J&L SEAMLESS CASING AND TUBING

Quality Control, through every step of manufacture, insures that J & L Seamless Casing and Tubing will give you leak-proof strings right from the start.

Write for Technical Paper "Leak-Resistance of Casing Joints in Tension."

J&L STEEL

J&L OIL COUNTRY PRODUCTS

SEAMLESS CASING AND TUBING · J&L INTEGRAL-JOINT DRILL PIPE
LINE PIPE · WIRE ROPE

JONES & LAUGHLIN STEEL CORPORATION

PITTSBURGH 30, PENNSYLVANIA

IDEAL

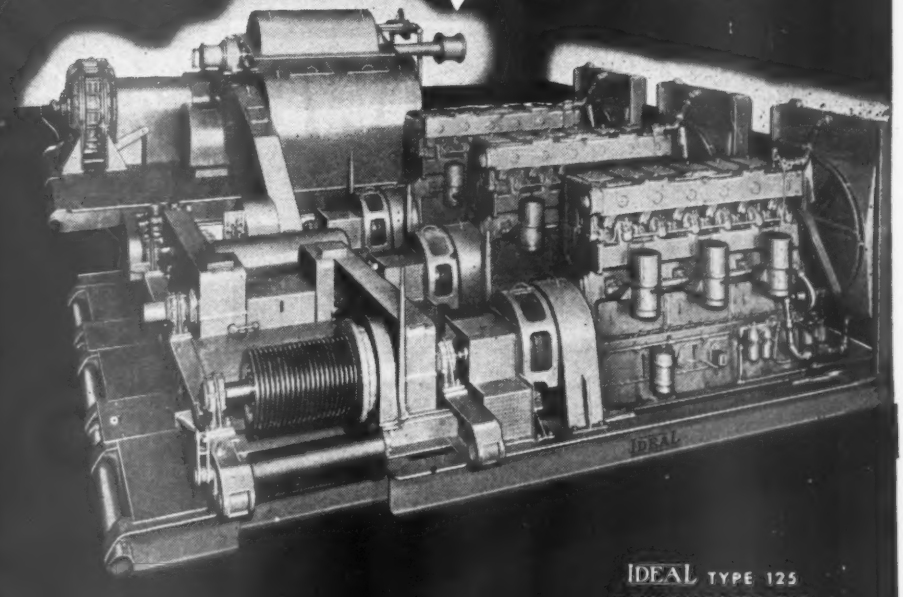
"Reg. U. S. Pat. Off."

CONSOLIDATED RIGS

for Every Oil Drilling Need

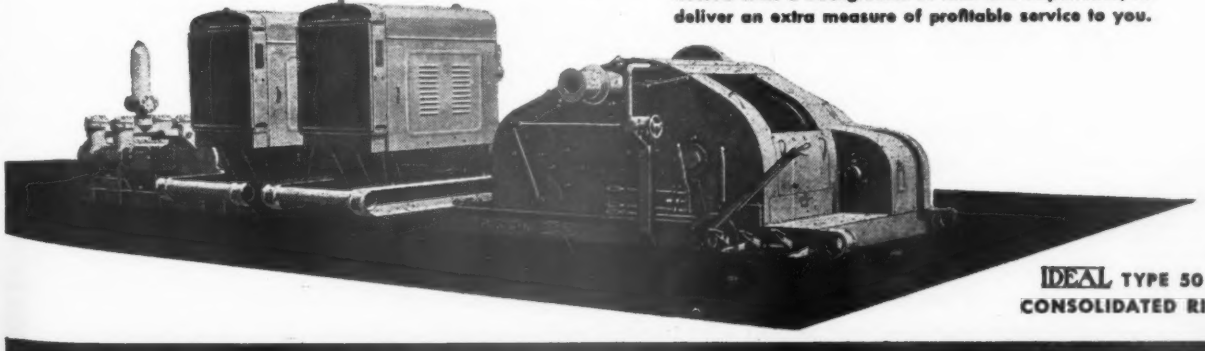
National's complete line of IDEAL Consolidated Rigs offers you the choice of a well balanced efficient outfit for any shallow or deep well drilling requirement.

IDEAL Rigs permit maximum flexibility and accuracy, with extreme ease of control, through the use of such features as the IDEAL Type K Brake, IDEAL Water-cooled Brake Rims, IDEAL Air-operated Friction Clutch, Air Control Valves, and Independent High Speeds.



IDEAL TYPE 125
CONSOLIDATED RIG

The National Supply Company is the only manufacturer who can offer a completely integrated drilling outfit such as IDEAL Consolidated Draw Works, IDEAL Drive Group with SUPERIOR Internal Combustion Engines, IDEAL Power Pumps, IDEAL Rotary Machine, Shrink Thread Drill Pipe, Shrink Thread Tool Joints, and other complementary equipment such as IDEAL Swivels, Blocks, Connectors, etc. All these products are engineered with a background of skill and experience, to deliver an extra measure of profitable service to you.



IDEAL TYPE 50
CONSOLIDATED RIG

THE NATIONAL SUPPLY COMPANY

General Sales Offices: Toledo, Ohio. Division Offices: Denver; Ft. Worth; Pittsburgh; Tulsa; Torrance.
Export: The National Supply Corporation, 30 Rockefeller Plaza, New York, N. Y., U. S. A.;
River Plate House, 12 South Place, London, E. C. 2.

now on the production line...

★ New power for a new world—that's what Sterling offers you now. As a result of war born techniques we have combined our nearly half century of uncompromising quality and precision practices with mass production procedure. You can now profit from this unbeatable combination in terms of lower prices, more power per pound of weight and less operation and maintenance costs. Illustrated are but four engines from the new Sterling line. Tell us what type engine you need and when you want it.

1 **PETREL Gasoline Six Cylinder Engine.** 5¼" bore, 6" stroke, 76 hp. to 190 hp. at 800 to 1800 rpm.

2 **VIKING Gasoline Eight Cylinder Engine.** 8" bore, 9" stroke, 345 hp. to 600 hp. at 700 to 1200 rpm.

3 **VIKING Diesel Eight Cylinder Supercharged Engine.** 8" bore 9" stroke, 220 hp. to 650 hp. at 400 to 1200 rpm.

4 **ADMIRAL Gasoline Twelve Cylinder Supercharged Engine.** 6⅛" bore, 6½" stroke, 450 hp. to 1800 hp. at 1000 to 2800 rpm.

STERLING ENGINE COMPANY, 1296 NIAGARA STREET, BUFFALO 13, N. Y.

New York City, 900 Chrysler Bldg. • Washington, D. C., 806 Evans Bldg. • Chicago, Illinois, 855 Board of Trade Bldg.

"KEEP BUYING WAR BONDS"

LONG TIME, NO REPAIR

"IT IS POSSIBLE TO OPERATE A NEW 'CARDWELL' DOUBLE DRUM RIG FOR A PERIOD IN EXCESS OF FOUR YEARS AND DEPRECIATE THE MACHINE PRACTICALLY TO ZERO BEFORE EXTENSIVE REPAIRS ARE NECESSARY."

BY Frank C. Newsom

NEWSOM DRILLING COMPANY

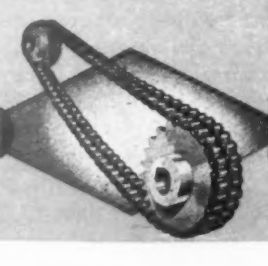
***Durable Rigs Have Durable Drives of* DIAMOND ROLLER CHAIN**

Reduced reproduction of Cardwell Mfg. Co. advertisement.

The operation of well-engineered durable rigs requires drives of equal durability. Years of performance in the field have proved to contractors, engineers, field superintendents, tool pushers and drillers the reliability of DIAMOND Roller Chain Drives.

Diamond Chains withstand successfully the shock stresses, the long hours of operation, the constantly increasing drill stem loads and greater torque requirements. Their use by leading rig builders assures low maintenance and maximum years of trouble-free service.

Diamond Roller Chain Drives on the equipment you buy is added insurance of low-cost drilling. DIAMOND CHAIN & MFG. CO., 441 Kentucky Avenue, Indianapolis 7, Indiana. Tulsa Office: 2238 Terwilleger Blvd.



DIAMOND ROLLER CHAINS

Houdry and TCC aviation fuel plants can be converted quickly to produce automobile fuel economically!

The satisfaction which Houdry licensees may well take in their ever-increasing output of aviation fuel is unmarred by any apprehension as to the post-war usefulness of their catalytic cracking equipment. For Houdry and TCC plants can be converted almost overnight to produce automobile gasoline of far higher quality than pre-war standards, yet more cheaply than by pre-war methods.

Houdry and TCC processes are adaptable to almost any size of refining operation (1,000 to 20,000 B/D) and any charging stock. They are licensed on a running royalty basis of 5c a barrel straight.

HOUDRY PROCESS CORPORATION
WILMINGTON, DELAWARE

Houdry Catalytic Processes and the TCC Process are available through the following licensing agents to all American refiners, subject to approval by the United States Government.

BECHTEL-McCONE CORP.
Los Angeles, Calif.

THE LUMMUS COMPANY
New York City, New York

E. B. BADGER & SONS CO.
Boston, Massachusetts

HANDLING YOUR OIL.... *Dependably*

Oil is worth careful handling above ground if it's worth drilling for and producing. That's the way thousands of operators figure it. And that's why thousands of producers are today depending on the care that Parkersburg Bolted Steel Tanks and Separators assure. We've been in the business of building dependable oil field equipment since 1897, we've constantly improved our products through engineering research, and we back up our products with know-how service that is unexcelled.

THE PARKERSBURG RIG & REEL CO.

PARKERSBURG & OCS PRODUCTS

GENERAL OFFICES, PARKERSBURG, W. VA

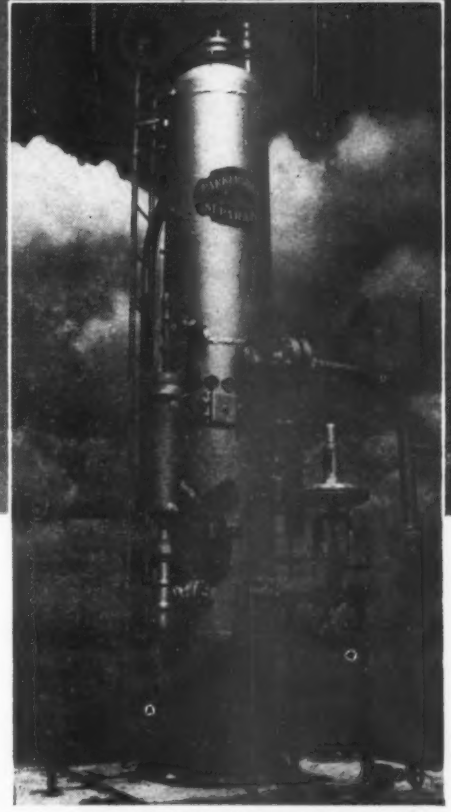
Plants at Parkersburg, W Va., Coffeyville, Kan

District Offices

Dallas - Houston - Los Angeles - Tulsa

New York

OCS



Inset: Parkersburg-Smith Separator on a Gulf Coast location. Background: The treating tank of a lease storage battery of Parkersburg Bolted Steel Tanks

THERMAL PARADOX

CARBON has *low* heat transfer properties. Graphite has *high*. Paradoxically . . . because they are one and the same element! We manufacture both forms . . . as well as "Karbate" material which is either one made impervious to fluid seepage.

The paradox makes possible widely diversified uses of carbon and graphite. Built-up carbon furnace linings, for example, *insulate* outer furnace walls, while keeping their strength and shape at the highest temperatures encountered. In contrast, graphite chill molds for furnace "over-runs" *cool metals quickly* without cracking or sticking, and save shop time, materials and mess.

In "Karbate" heat exchangers, high heat transfer goes hand-in-hand with resistance to practically all corrosive chemicals . . . plus strength and dimensional stability.

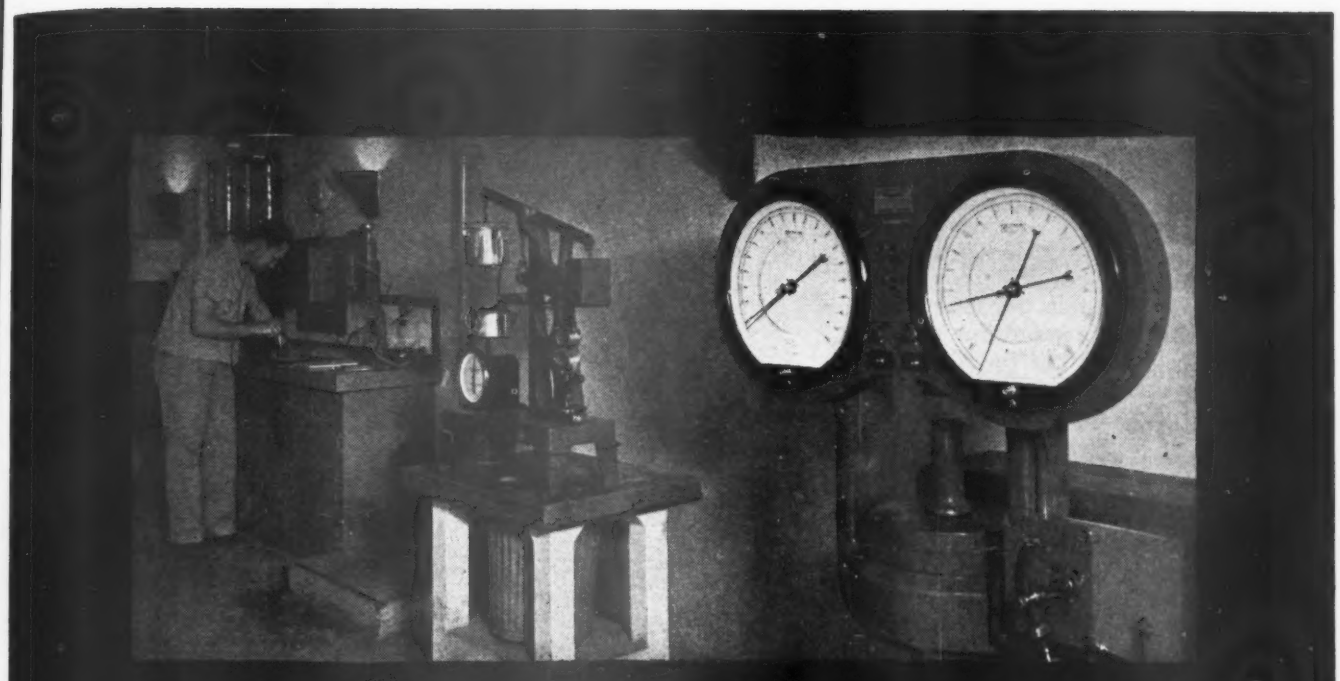
These and many other chemical, metallurgical or textile industry applications of "National" carbon and graphite and "Karbate" specialty products depend on their sometimes paradoxical but always broad combination of useful properties. Inquiries are invited.

BAR OF WHAT?
Carbon, Graphite, or "Karbate" materials, of course!

KEEP YOUR EYE ON THE INFANTRY . . . THE DOUGHBOY DOES IT!

NATIONAL CARBON COMPANY, INC.
Unit of Union Carbide and Carbon Corporation
UCC
General Offices: 30 East 42nd Street, New York 17, N. Y.
Division Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

The registered trade-marks "National" and "Karbate" distinguish products of National Carbon Company, Inc.



CEMENT RESEARCH—

ASSURES OUTSTANDING PERFORMANCE, TODAY AND TOMORROW

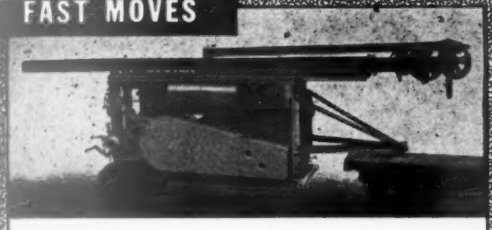
CONTINUING Oil-Well Cement Laboratory research, guided by day-by-day field contact—plus rigid quality control in mill production—assures outstanding performance, in the field, today and tomorrow. Use 'STARCOR'* for deep wells, high sulphate resistance. For deepest wells, 'TEXCOR'*, with extra-long thickening time and high sulphate resistance. 'INCOR'* for earlier drill-out in moderate-depth wells. LONE STAR CEMENT for dependable all-around service. Protect your investment by using the Cement that fits your well!

*Reg. U. S. Pat. Off.

LONE STAR CEMENT CORPORATION • DALLAS • HOUSTON

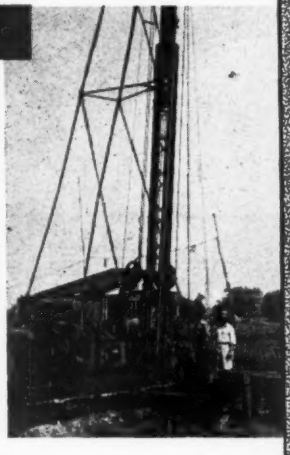
The 36-L *Performance Story* Means Profit For You

FAST MOVES



Designed for high speed transportation, the 36-L can be moved at speeds of 30 miles per hour and faster with this semi-trailer mounting. Also available is skid-type base for easy skidding to derrick floors, trucks, mudboats.

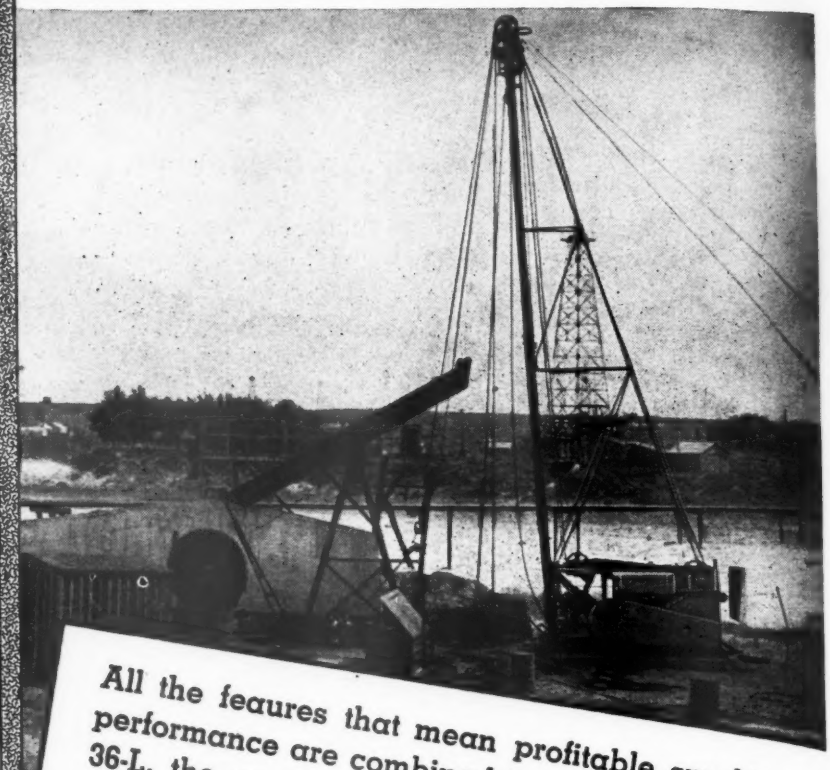
VERSATILITY



Profitable handling of tailing-in, top-to-bottom, clean-out, deepening, swabbing, servicing, and fishing makes the 36-L an all-around profit producer. With the 36-L you're "ready for anything."

SMOOTH ACTION

The exclusive rubber shock absorber under the crown sheave keeps drilling smooth with minimum vibration, imparts elasticity and long life to the drilling cable, lets tools strike a sharp, snappy blow for real footage.



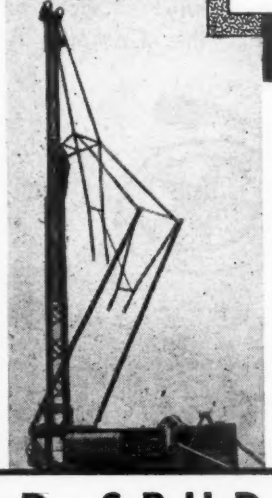
All the feaures that mean profitable spudder performance are combined in the Bucyrus-Erie 36-L, the spudder of tomorrow. Fast, smooth drilling action, complete mobility, ability to handle many jobs, easy operation — these are just a few of the reasons why the 36-L will be outstanding for your work. Look over the features on this page — they'll tell you a story that means profit for you.

K-53

SOUTH MILWAUKEE **BUCYRUS ERIE** WISCONSIN

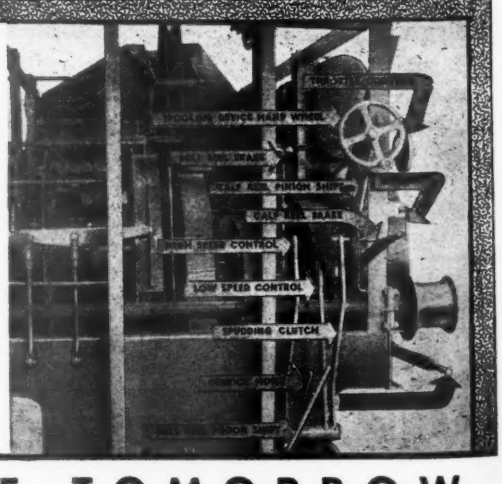
REPRESENTATIVES IN ALL PRINCIPAL OIL FIELDS

QUICK SET-UPS



In 20 minutes, two men can easily raise or lower the derrick on a 36-L. A strong latticed steel box structure of the telescoping type, the derrick is extended and raised by a worm-gear driven power winch. Folding tubular braces keep derrick secure.

EASY OPERATION



The convenient arrangement of controls on a Bucyrus-Erie saves time, makes operating easy. All controls are grouped together close to the hole for quick action if trouble starts.

OILFIELD SPUDDERS OF TOMORROW

Searching for better alloys...

to give you BETTER TUBING

Ever since B&W produced first seamless alloy steel tubing commercially back in 1922, it has continued to pioneer important improvements in tubing for high temperature, high pressure, oxidation and corrosion-resistant services. Day in day out in B&W large, complete tube laboratories, engineers and technicians are diligently and constantly searching for better alloys or how to improve present alloys that will extend the life, reduce maintenance, and increase dependability of tubing in refineries, synthetic rubber plants and chemical plants.

Today B&W seamless tubing is available in a complete range of alloy steels. *That means there's a B&W tube for any refinery need.*

Improvements being made in seamless tubing at B&W are available for both your present and future requirements. More and more tube users are taking advantage of B&W tube engineering and production facilities these days. Reason is B&W is in position to match tubes to jobs without prejudice toward any type. By bringing your tube problems to B&W you also centralize your purchasing problems.

B&W TUBES

SEAMLESS. Complete range of carbon and alloy steels. Sizes: ½ in. to 8⅝ in. O.D.

ELECTRIC-Resistance Welded Carbon grades. Sizes: ¾ in. to 4 in. O.D.

THE BABCOCK & WILCOX TUBE COMPANY

Seamless Tube Division, Beaver Falls, Pa. — Welded Tube Division, Alliance, Ohio

B & W MAKES BOTH

TA-13(

American industry flows through fairbanks valves

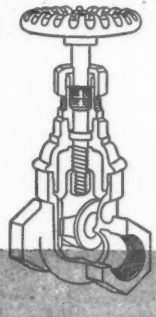
STEEL... strength of a nation

Supplier of sinew for mighty war machines, steel means business from the first flares of its fiery birth. To the clang of giant hammers shaping it to man's use, steel as a metal and as an industry is piling up a year-after-year performance record that staggers imagination.

Steel is vital to our economy in a way no other material can parallel. And in no other field is the service of valves by the thousands more important to steadily-maintained high levels of essential production.

The large quantities of Fairbanks Valves used in the steel industry afford a striking example of what we mean when we say "American Industry flows through Fairbanks Valves." This wide line of bronze and iron valves is backed by more than fifty years of frequent advances in manufacturing . . . consistent improvements in materials.

Fairbanks Catalog Number 42 gives specifications, prices. If it's not in your files now, we suggest you write today. When we send it, we'll advise you of nearest distributor.



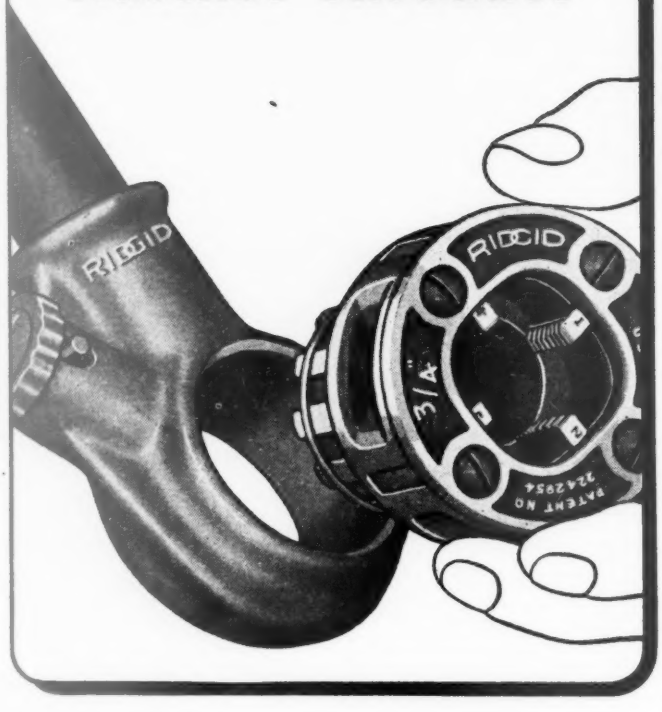
THE fairbanks COMPANY

393 LAFAYETTE STREET, NEW YORK 3, N. Y.

320 Atlantic Avenue, Boston 10, Mass. • 15 Ferry Street, Pittsburgh 22, Pa.

POWER TO WIN
Skilled experience in Research, Design, Engineering Development, Facilities, Correct Tooling, Coordinated Planning and Manufacturing plus many Continental features, including Individual Porting, Roto Valves and Con-Tem Cooling Systems are responsible for dependable Red Seal Power – the Power to Win.
ARMY E NAVY
Awarded to the Detroit and Muskegon Plants of Continental Motors Corporation for High Achievement
Your Dollars are Power, Too!
Buy War Bonds and Keep Them!
SALES AND SERVICE
NATIONAL WELDING & GRINDING CO. Dallas
C. JIM STEWART & STEVENSON CO. Houston
STANDARD TOOL & MACHINE CO. Longview
DIESEL POWER & MACHINERY CO. Oklahoma City
DIESEL POWER & MACHINERY CO. Tulsa
WICHTEX MACHINERY CO. Wichita Falls
IVERSON TOOL CO. Branches: Artesia, N. M.; Borger, Tex.; Odessa, Tex.; Tampa, Tex.; Wink, Tex.; Oklahoma City, Okla.; Okmulgee, Okla.; Salem, Ill.
Continental Motors Corporation
MUSKEGON, MICHIGAN
Continental
Red Seal
Engines

You'll enjoy using this smart little RIDGID Ratchet Threader



Die Heads lock in either side

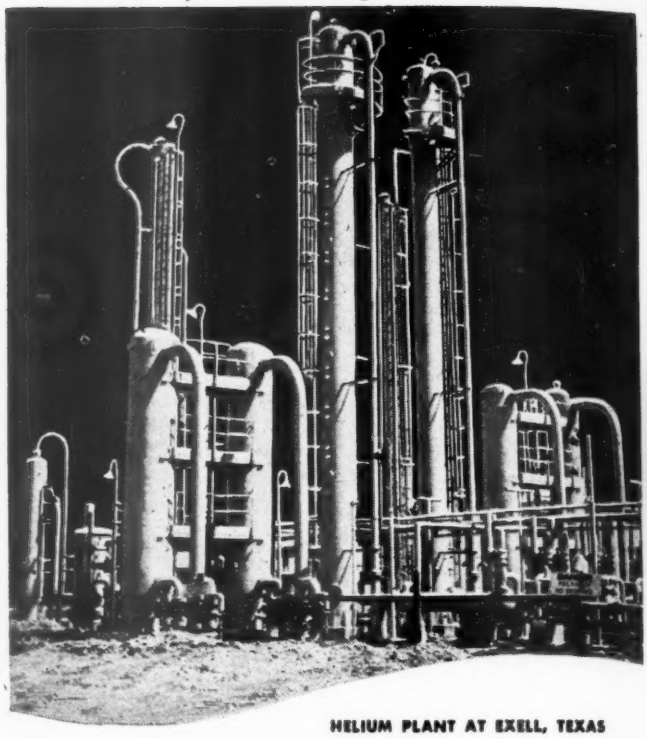
● This 111R threader is a time-saver on pipe from ⅛" to 1¼". Click the size die head you want into the ratchet ring, from either side. No special dies needed for close-to-wall threads, just reverse the alloy steel chasers, easily removed also for regrinding. You'll like this efficient rugged little steel-and-malleable threader—ask your Supply House. We're trying our hardest to meet the big demand for RIDGIDS . . . your patience is greatly appreciated.

Handy carrier with any combination of sizes.

RIDGID

WORK-SAVER PIPE TOOLS

THE RIDGE TOOL COMPANY · ELYRIA, OHIO, U. S. A.



HELIUM PLANT AT EXELL, TEXAS

HELIUM RECOVERY *makes use of* Florite*

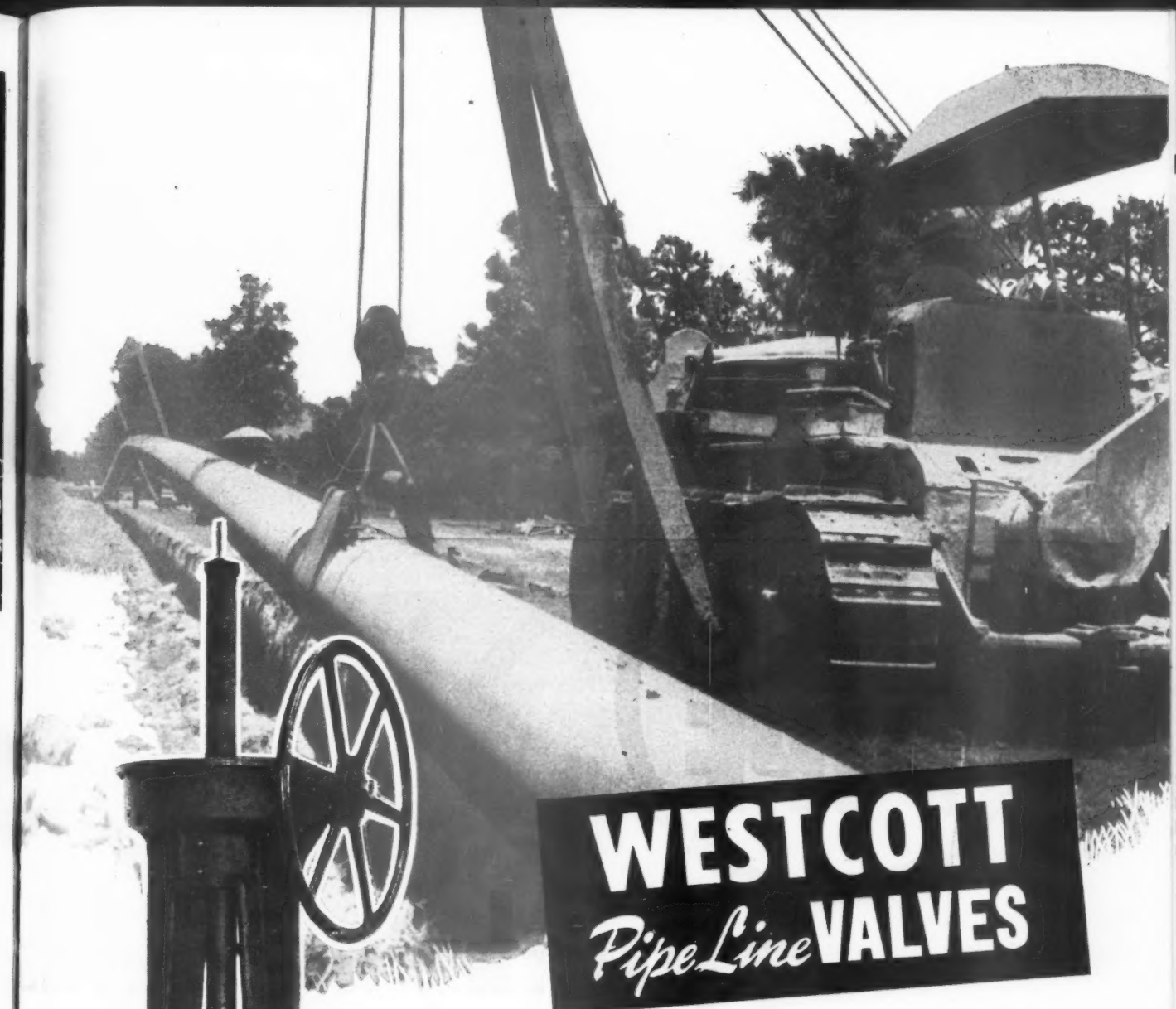
The fact that granular Florite Desiccant is employed as a drying agent in the processes of modern helium recovery at the Exell, Texas, helium plant of the U. S. Bureau of Mines, is one of many examples of the adaptability of Floridin products to a wide range of exacting uses. As adsorbents, desiccants, catalysts and catalyst carriers, Floridin products have become widely known and approved by the petroleum, vegetable-oil refining, and chemical manufacturing industries. Write for descriptive material, indicating what application you have in mind.

*Trade Mark Registered.

FLORIDIN COMPANY, INC.

ADSORBENTS

Room 54, 270 Liberty Street Warren, Pa.



WESTCOTT *Pipe Line* VALVES

NOTHING can be left to chance in the control of today's pipe lines. Nothing is left to chance in the manufacture of Westcott Pipe Line Valves.

Westcott valves are precision built for the oil and gas industries exclusively. They are designed with the assistance of men who know best what a valve must be to give proper, dependable operation . . . the pipe line operators themselves.

For positive control insurance, specify Westcotts. Your Continental representative has all the details.

THE CONTINENTAL SUPPLY COMPANY

General Offices: DALLAS, TEXAS

EXPORT DIVISION

30 Rockefeller Plaza New York City, N. Y.

Representatives

MEXICO ARGENTINA ENGLAND TRINIDAD BRAZIL

CONTINENTAL

SERVING THE OIL AND GAS INDUSTRIES

..it fits the oil fields like a glove!

You specify J & L tubular goods for pipe line and other oil field jobs for the same good reason that you want experienced, competent, conscientious men.... It gets the job done.

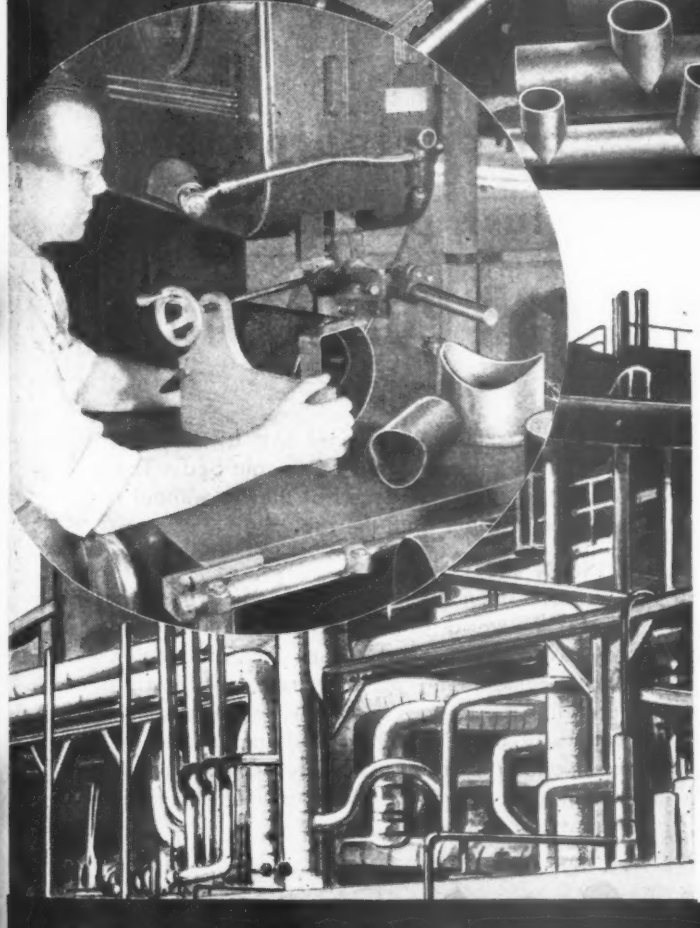
JONES & LAUGHLIN SUPPLY COMPANY

Subsidiary of Jones & Laughlin Steel Corporation

TULSA, OKLAHOMA

J&L STEEL

DoALL



DoALL is a natural for pipe men—for maintenance work—for straight line cutting, odd shaping or contour work. Rounded joinings at the left are made on the DoALL in 8.28 to 15.00 minutes each, depending on size.

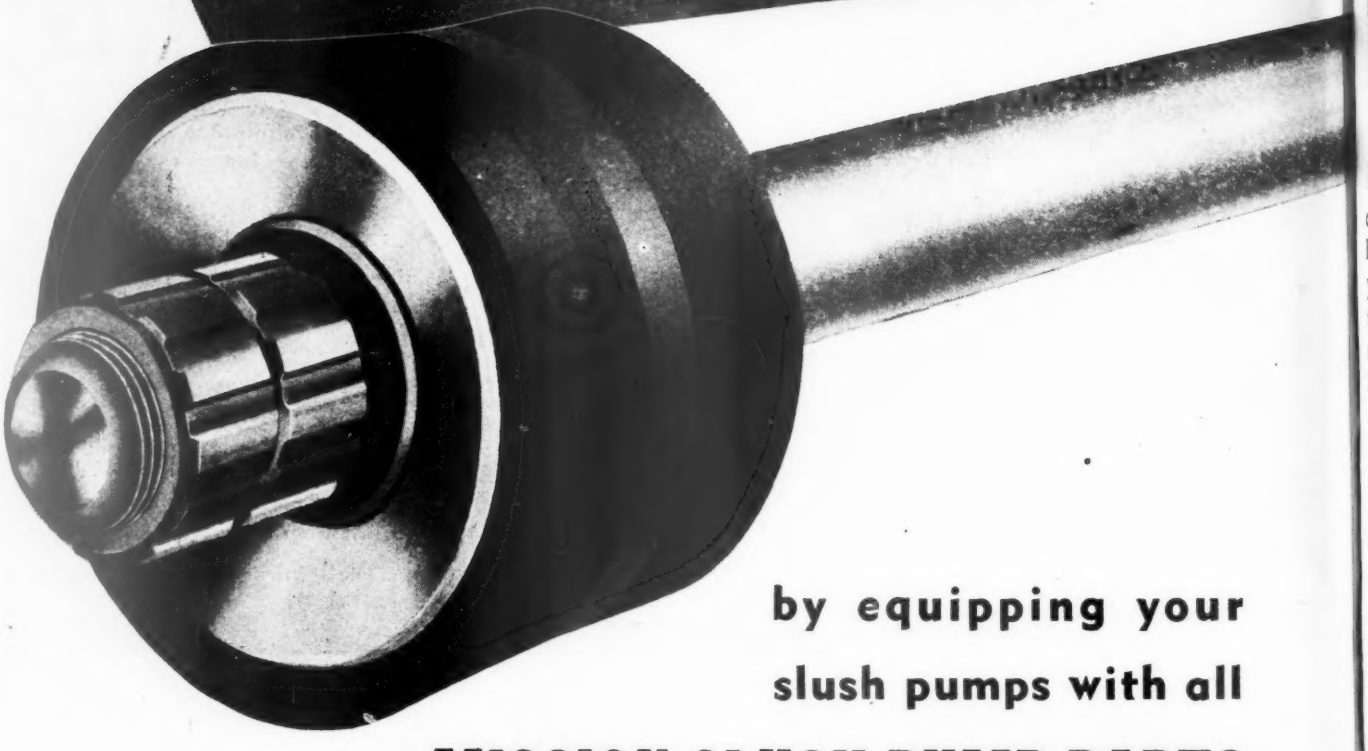
Today DoALL is death to bottlenecks and is saving thousands of valuable man hours in war plants. Work on metals, alloys, laminates, plastics and wood—piping and tubing, bar stocks, blocks a foot thick, stacked sheets.

Investigate the DoALL—6 models to choose from. Write for illustrated literature.

DoALL

CONTINENTAL MACHINES, INC.
1325 S. Washington Ave. • Minneapolis 4, Minn.

SPEED UP YOUR DRILLING...



by equipping your slush pumps with all

MISSION SLUSH PUMP PARTS

MISSION *Fluid End* PISTONS
GIVE YOU EXTRA LONG SERVICE **because of the extremely long, trouble-free piston rubber life. These rubbers are usually giving good service long after ordinary pistons have worn out due to: 1, the combination of tough rubber compound and advanced design; 2, the large wiping surface and positive seal, assuring longer life for rubbers. Other advantages accruing from this principle are longer liner life, more fluid per stroke, and more hole per hour.**

Replaceable Rubbers Reduce Piston Renewal Cost—When after a long, uninterrupted run, the rubbers are finally worn out, the piston is renewed at much less than its original cost by simply installing new piston rubbers on the old body. These rubbers are easily replaced at the rig without removing the piston from the rod.

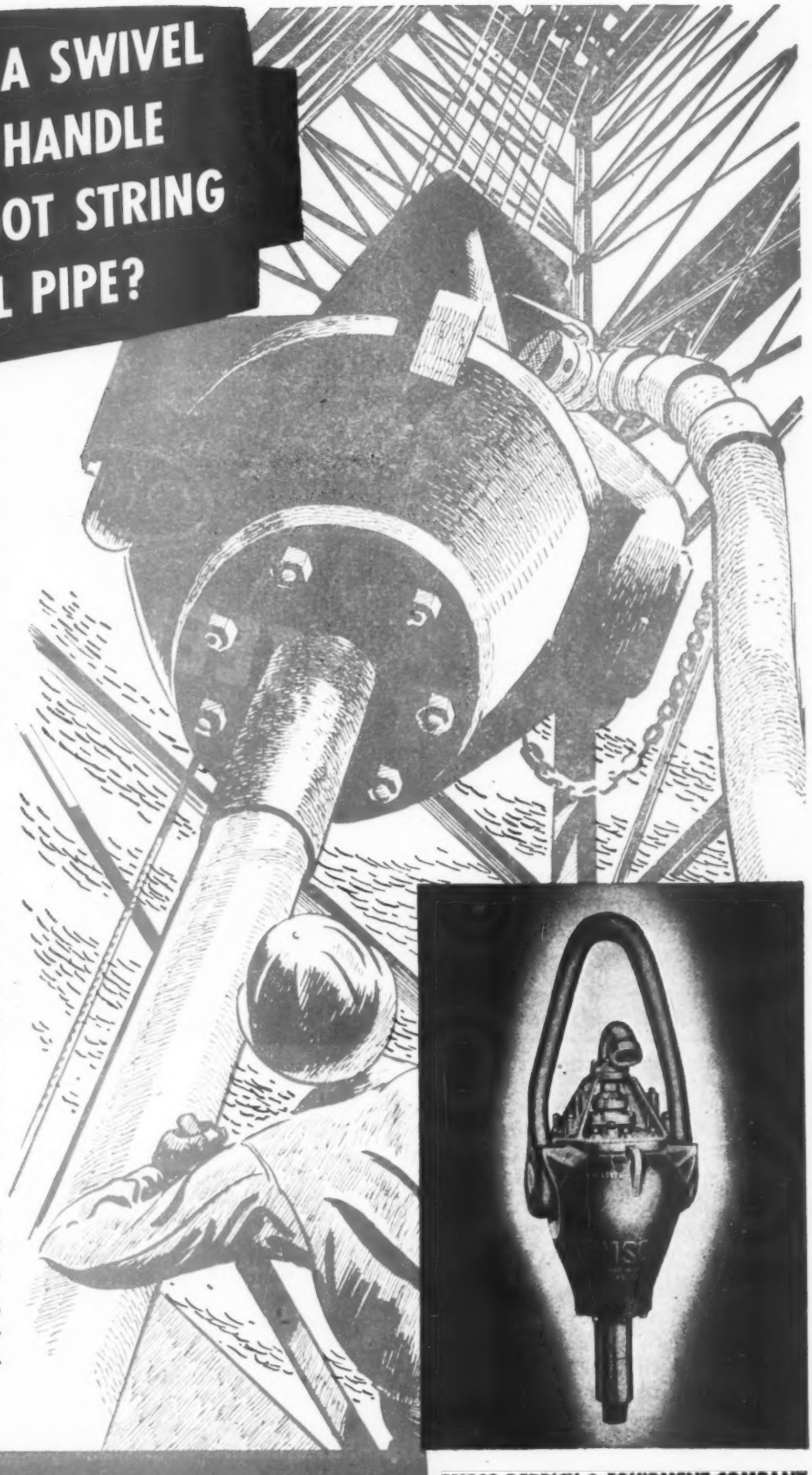
MISSION PISTON RODS
. . . have been the choice of leading operators all over the world for years. The excellent wearing qualities of the file-hard surface is due to Mission's special combination of heat treatment and rod material. These rods combine a core tensile strength of over 120,000 pounds per sq. in. with exceptionally high ductility. This combination of strength and toughness gives maximum protection against rod breakage.

USE ALL MISSION PUMP PARTS
VALVES, PISTONS, RODS AND GLAND PACKINGS

4A-17

Mission MANUFACTURING CO.
HUMBLE ROAD HOUSTON, TEXAS
Export Office, Room 1636, 30 Rockefeller Plaza
New York 20, N. Y.

WHO WANTS A SWIVEL THAT WILL HANDLE A 50,000 FOOT STRING OF DRILL PIPE?



NOBODY, we hope! But if the time ever comes when a swivel must handle drill string of that length, you can count on Emsco having a swivel developed to handle the tremendous loads involved. For Emsco Swivels are already built to meet rigid ratings far in excess of conditions encountered under actual drilling practice. It's reassuring to know that with an Emsco Swivel you have capacity for greater loads than the deepest drilling now calls for.

Emsco Swivels are especially designed so that all bearings are rigidly supported by the housing, thus eliminating distortion under heavy loads. Packing is of the self-sealing type, automatically conforming to varying pressures, and eliminates the necessity of adjusting wash pipe glands with wrenches. A mud throw-out bonnet of the tongue and groove type is especially provided to prevent the entrance of mud, water, or other foreign substances to the swivel body.

Emsco Swivels are costly to build but they're worth every cent which goes into them. They reduce overall drilling costs because of their long life, their resistance to costly breakdowns, and their reliable performance under difficult conditions.

EMSCO

REG. U.S. PAT. OFF.

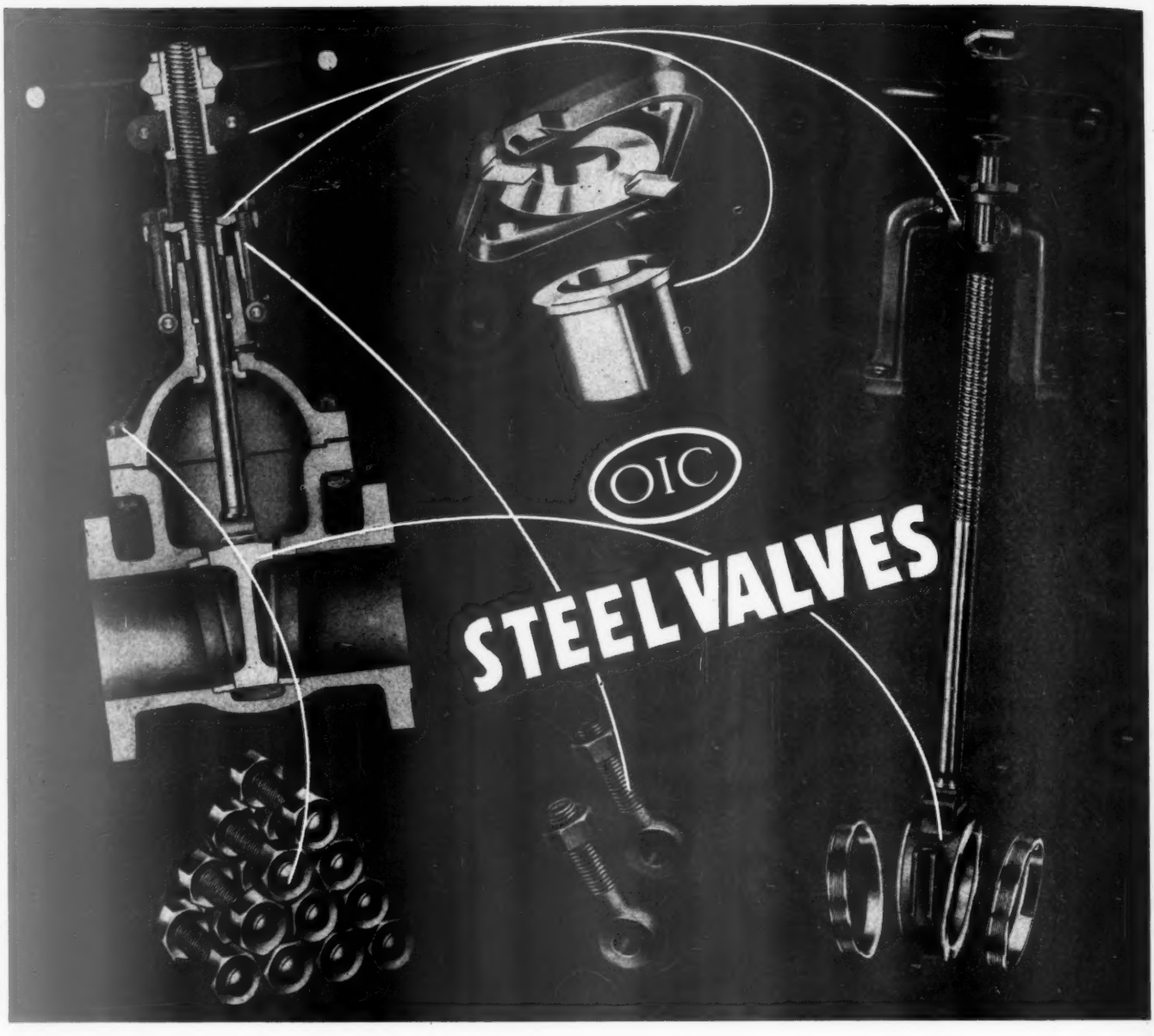
DALLAS PLANT
HOUSTON PLANT

EMSCO DERRICK & EQUIPMENT COMPANY

Houston, Tex. • Los Angeles, Calif. • Dallas, Tex.

Distributors:

Continental United States, Except California, Oregon and Washington... THE CONTINENTAL SUPPLY COMPANY, Dallas, Tex. • California, Oregon and Washington... EMSCO DERRICK & EQUIPMENT COMPANY, Los Angeles, Calif. • Export and Eastern Canada... THE CONTINENTAL SUPPLY COMPANY, INC., New York, N. Y. • Western Canada... THE TURNER VALLEY SUPPLY CO., LTD., Calgary, Alberta, Canada.



MATCHING the superior qualities of OIC Bronze and Iron Valves that have been outstanding for more than 60 years, OIC Cast Steel Valves are in pace with today's emergency demands . . . filling a definite need wherever steel valves are required.

Combining time-proved features with tested modern refinements, they equal and exceed the quality and performance standards set by the principal users' and manufacturers' specifications.

OIC Cast Steel O.S. & Y. Gate Valves are built to control fluid flow dependably and absolutely. They are contributing vitally to the efficient operation of:

Petroleum Refineries
Oil & Gas Pipe Lines
Central Power Generating Plants
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OIC Steel Gate Valves* are regularly available in trims suitable for oil, oil vapor, steam, water, gas or air service over a broad range of pressures and temperatures. Valves with trims for other services available on special order.

There is an OIC Distributor near you, ready to demonstrate to you the many superior features of OIC Cast Steel Valves. Call him . . . or write to us for details.

***Also available are companion OIC Steel Globe, Angle and Swing Check Valves.**

ARMY E NAVY

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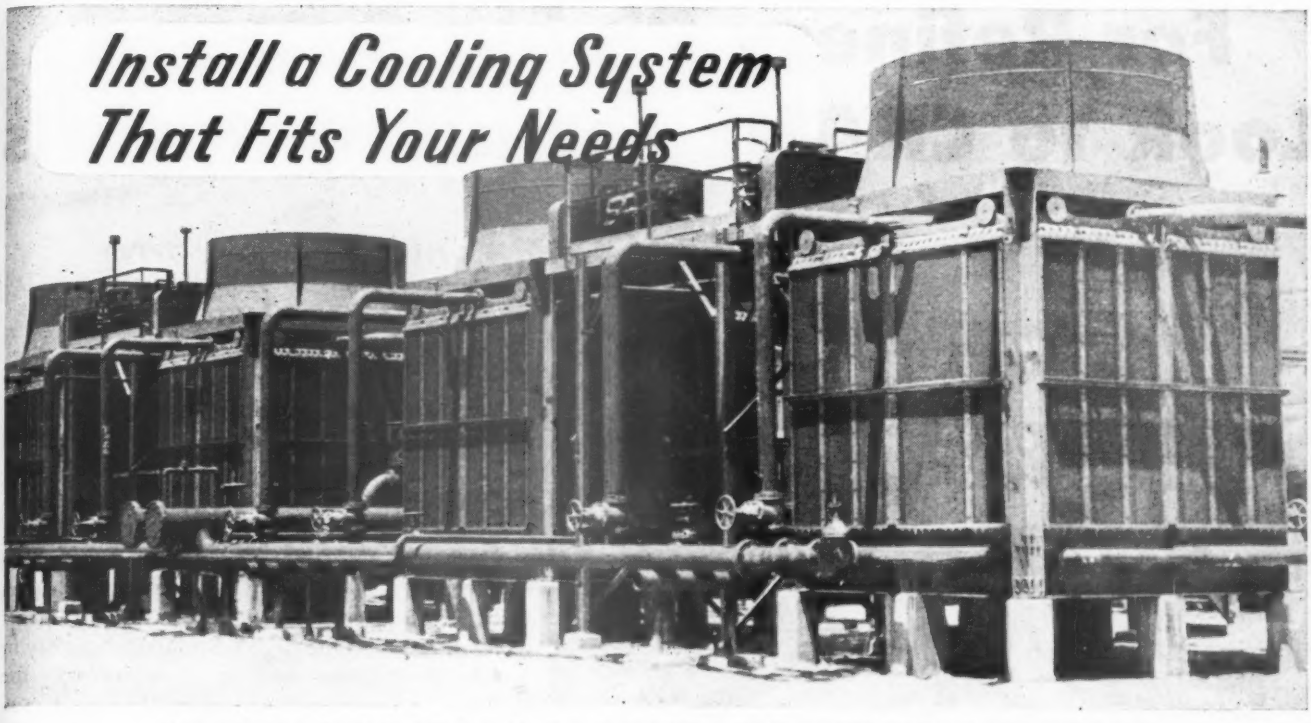
THE OHIO INJECTOR COMPANY
WADSWORTH, OHIO
Quality Leaders in Valve Manufacture Since 1883

Install a Cooling System That Fits Your Needs



Young-Happy Quad Installation Cooling Jacket Water For Seven 600 HP Gas Compressor Engines

The many advantages of using YOUNG - HAPPY Atmospheric Cooling Equipment for cooling engine jacket water and lubricating oil, apply equally as well to larger engine and plant installations as to individual units.

SAVES ENGINES YOUNG-HAPPY Coolers, being an enclosed system, completely avoid scale and corrosion in engine jackets; or scale and corrosion from outer exchanger surfaces.

SAVES POWER Uniformity in temperature control is obtained by operating only those fans necessary under existing atmospheric conditions.

SAVES WATER AND PAINT Using but a few gallons of water daily, without waste or drift, YOUNG-HAPPY Coolers not only conserve water supply, but also eliminate damage to paint and other equipment.

SAVES LOSS FROM MOVING Salvageability of this equipment is high, as only a minimum of foundation or concrete work is necessary to install, if ever relocated.

"Happy Chases Heat"

YOUNG-HAPPY Coolers are backed by many years of engineering and manufacturing experience

Let us apply our experience to your cooling problems Just drop us a line.

The HAPPY COMPANY

Formerly HAPPY BELTING COMPANY

TULSA, OKLAHOMA

Seminole, Oklahoma . . . Smackover, Arkansas . . . Odessa, Kilgore and Pampa, Texas . . . Salem, Illinois . . . Wichita and Ellinwood, Kansas.

Rubber Belting

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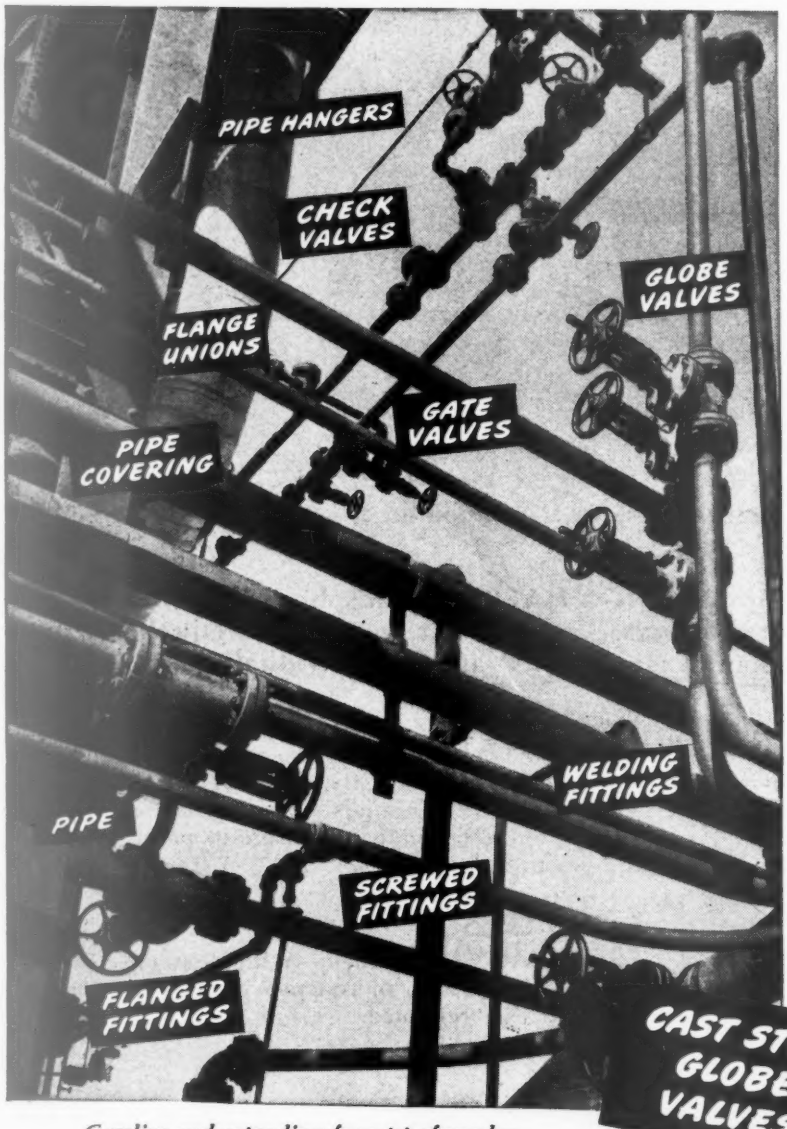
Happy Pumping Units

Young-Happy Engine Jacket Coolers

Power Transmission Equipment

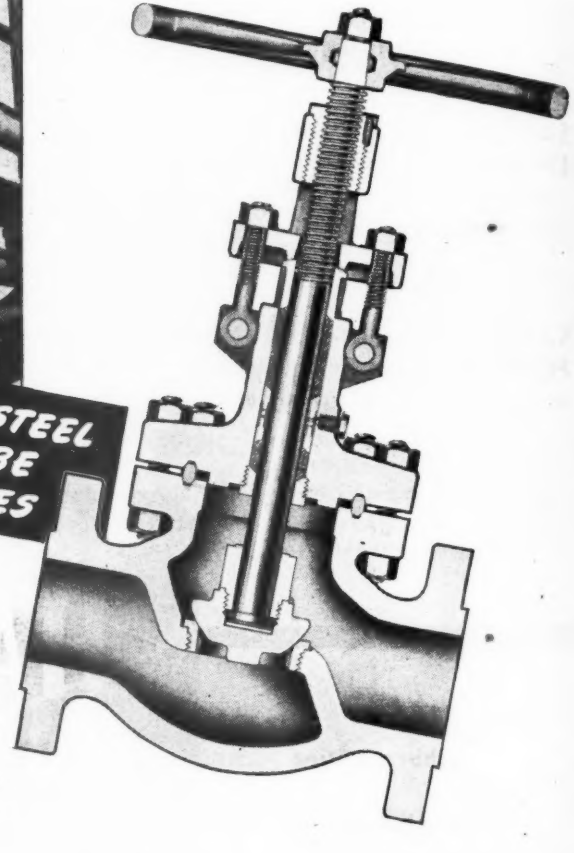
For Refinery Piping Systems Look to CRANE for all Materials



Gasoline and vapor lines from top of cracker

- **ONE SOURCE OF SUPPLY**
- **ONE RESPONSIBILITY FOR ALL PARTS**
- **ONE STANDARD OF QUALITY**

Simplify your task of making deferred replacements and keeping piping systems at peak efficiency. Use Crane *complete* piping materials service. One source—your Crane Branch or Wholesaler—supplies all your requirements for any job. One high standard of quality in all piping parts—and one responsibility for them—help assure the best installations. Crane Co.'s 90-year leadership in the piping equipment field insures your complete satisfaction.



SERVICE RECOMMENDATIONS: **Crane Cast Steel Globe Valves with ball-type disc as shown here are specially designed for oil services. With Exelloy trim, they are recommended for all oil or oil vapor service at temperatures over 500° F. and for most corrosive and unrefined oils regardless of temperatures. These valves are available for all working pressures up to 2500 pounds at 1100° F. Made in all sizes; with screwed, flanged, or welding ends. See your Crane Catalog for complete specifications on these and other complete lines of Crane Steel Globe and Angle Valves.**

CRANE CO., General Offices: 836 S. Michigan Ave., Chicago 5, Ill. • *Branches and Wholesalers Serving All Industrial Areas*

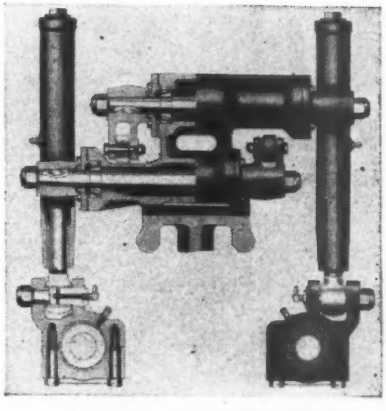
CRANE 90 YEARS OF PROGRESS 1855 1945

VALVES • FITTINGS • PIPE
PLUMBING • HEATING • PUMPS

Smooth AND QUIET—

Packed with power for the deepest well . . . plenty of power for all types of formations . . . yet smooth and quiet in operation. These are the reasons why Gardner-Denver Steam Slush Pumps have been chosen for so many rotary drilling jobs.

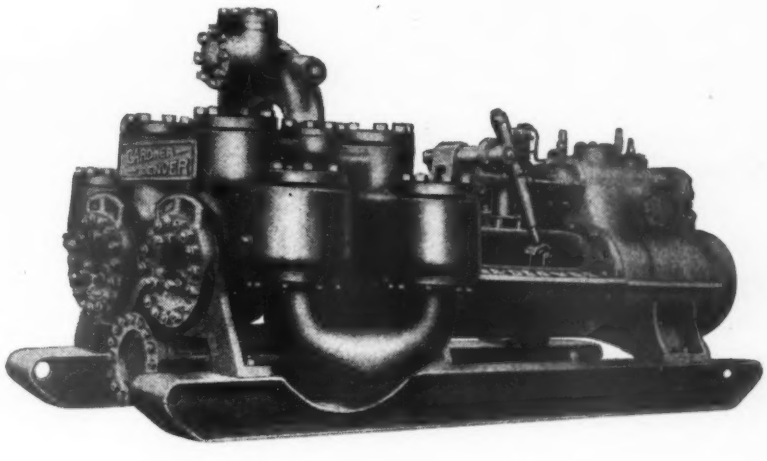
That smoothness and quiet operation are the result of the famous Gardner-Denver telescopic valve action. The enclosed, roller bearing steam valve gear, equipped with telescopic levers is practically noiseless . . . assures smooth, quiet operation. There's plenty of power here, yet it's always under perfect control.



Telescopic valve gear

OTHER "SMOOTH" FEATURES

1. **Higher lifts . . . less fluid friction because passages and suction manifold are streamlined for smooth flow.**
2. **SLUSHPROOF hardened rods and liners offer extreme resistance to pressure and abrasion.**
3. **Pistons and cylinders cast in GarDurloy for longer life.**
4. **Steam cylinders designed for 400 pounds maximum pressure . . . fluid cylinders hydrostatically tested to 6000 pounds pressure.**



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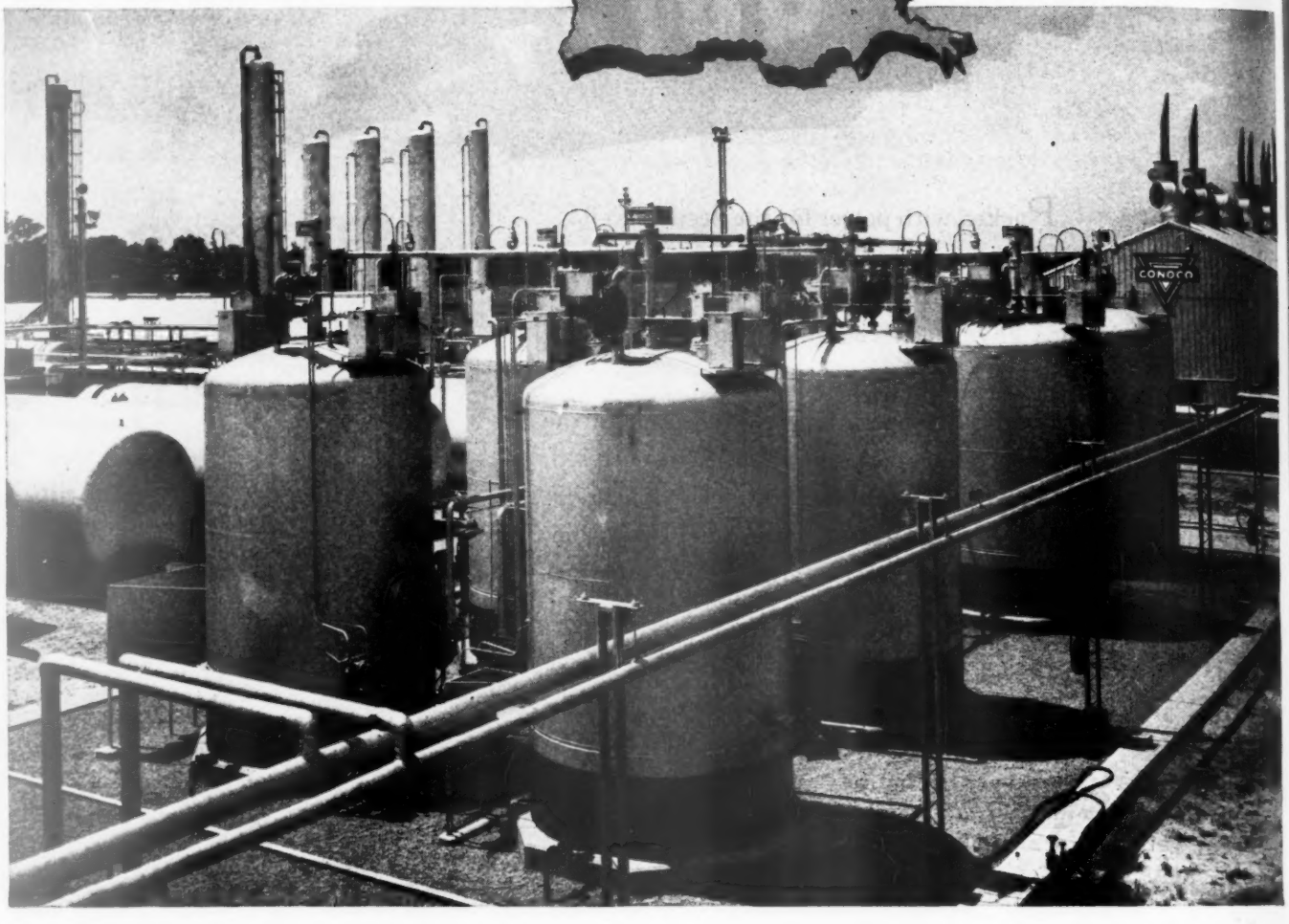
Gardner-Denver Company, Quincy, Illinois . . . Dallas—Houston—Tulsa—St. Louis—Los Angeles—San Francisco—New York—Chicago—Pittsburgh.

Continental Supply Co., Continental Bldg., Dallas, Texas. Republic Supply Company (of California) 2122 E. 7th Street, Los Angeles, California.

GARDNER-DENVER *Since 1859*

In Louisiana... where salty crude is an operating problem CONOCO relies on Petreco Desalting



OIL MEN everywhere recognize the outstanding achievements of Continental Oil Company. Conoco as an important unit of an industry dedicated to maximum production for war, utilizes proven methods and processes which insure the greatest efficiency.

It is significant that where salt-bearing crudes are encountered, Conoco employs Petreco Desalting. It is significant also that Conoco first installed a single unit Petreco desalter . . . followed by three Petreco units in another plant . . . and quickly thereafter by an additional installation of eight Petreco units. Recently Petreco completed a specially designed high-capacity desalter for Conoco in still another refinery.

These "repeat" installations for a company of Continental's caliber are graphic proof that Petreco Desalting efficiently conditions crude to meet strictest manufacturing specifications.

PETROLEUM RECTIFYING COMPANY

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530 West Sixth Street, Los Angeles 14, Calif.
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Representatives in all principal fields and refining centers

PETRECO

DESALTING • DEHYDRATING

McCullough

Puts the Shots where they count!

Location, Exact Spacing

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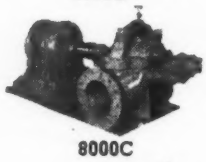
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CAPACITY OIL BURNER

TYPE SAL

for firing Large Boilers in Petroleum Refineries and Chemical Plants, etc.

Up to 600 gallons of heavy oil per burner per hour can be burned efficiently with the Type SAL. This is about 90 million B. T. U. Operates equally well using either steam or compressed air for atomization . . . needs only occasional cleaning and a minimum of maintenance.

The SAL is installed frequently as an alternate to pulverized coal, coke or natural gas in boilers up to one million pounds per hour steam capacity.

Our 33 years experience in the manufacture and application of fuel oil and gas burners can help you meet your combustion problems. Call on us.

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NATIONAL AIROIL
FUEL OIL - GAS
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WHY WE BUILD *Muscle* INTO PURPLE STRAND ROPE

Many's the time you've watched your Purple Strand rotary line hauling up drill pipe. Looks pretty simple, for Purple Strand is built to handle the load easily. But did you ever stop to figure the actual tonnage that hangs from the hook as the string starts up?

Suppose you're at 12,000 feet, using 4½-inch pipe. The string, we'll say, weighs around 16½ pounds per foot. Your total is nearly a hundred tons of drill pipe—a tonnage equivalent to the weight of twenty good-sized elephants.

To raise such a load, rotary line needs muscle. That's why every foot of Purple Strand is precision-built; why it's designed, fabricated, and tested by craftsmen with years of experience. Those men *know* the loads it has to handle in rotary work.

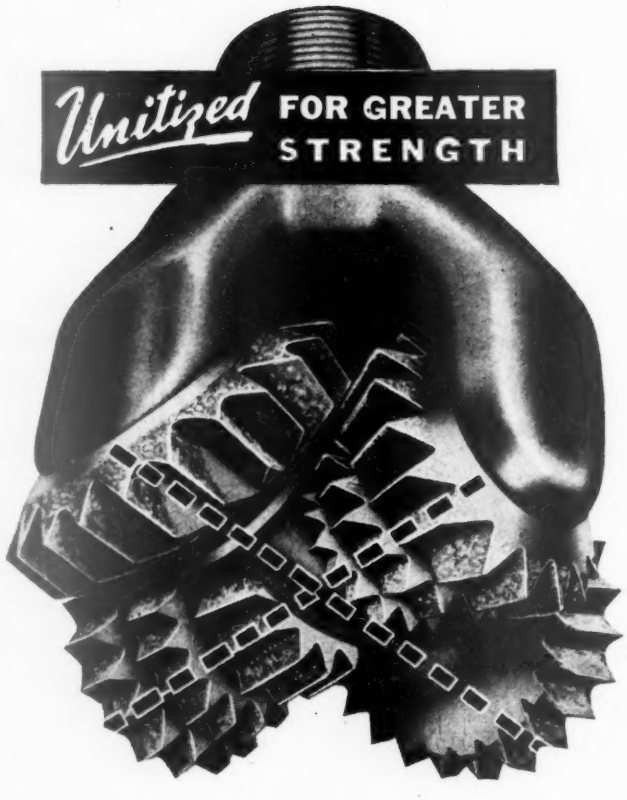
Because of the high speeds and severe stresses encountered at the drum, Purple Strand is frequently specified in the Form-Set (preformed) construction. Buyers like Form-Set's easy spooling; even more, they like the way it resists destructive bending fatigue. Preformed rope is a durable, "wearable" rope... it's a good bet for long-range overall economy.

When you think WIRE ROPE

... think BETHLEHEM

"You get faster, safer hole with REED ROCK BITS... the Bit that requires Less Weight!"

Says
A. G. CHANDLER
REED EASTERN DIVISION MANAGER
SALEM, ILLINOIS



And YOU SAVE ON YOUR RIG MAINTENANCE COSTS ALL THE WAY DOWN

•

Reed Rock Bits drill faster with less weight because of the twisting, tearing action of the cutter teeth, inherent of the basic Reed design.

Fast drilling with light weights, which is possible in nearly all formations, results in a substantial saving on rig maintenance all the way from the crown block to the bit. Where it is necessary to use heavy weights as when drilling extremely hard formations, the basic Reed cross-roller design which gives individual support to the cutters, makes for greater strength and safety.

•

Reed
ROLLER BIT COMPANY
HOUSTON 1, TEXAS

FORGED FOR ENDURANCE...

LADISH FLANGES

There is no Substitute for Quality

Wherever flanges are used, the extra measure of safety and endurance that protects pressure piping systems against costly breakdowns is Controlled Quality.

Ladish flanges are produced under exacting metallurgical control and each bears the symbol of Controlled Quality identification . . . the Ladish Heat Code.

ARMY-NAVY "E"

TO MARK PROGRESS

FITTINGS DIVISION

LADISH DROP FORGE CO.

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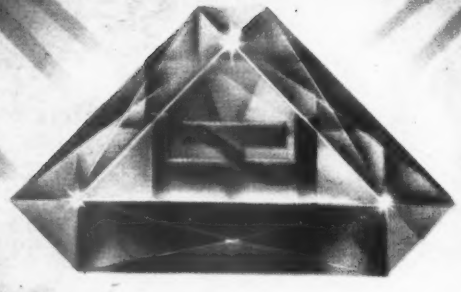
1945

QUALITY . . .

damental with Hughes



in oil fields the world over, Hughes Specialized Oil Field Tools, through dependable performance, are making a major contribution, and particularly in the aggressive search for new producing horizons. Thirty-five years of experience in manufacturing quality drilling equipment goes into the making of every Hughes Tool.

There is no ***substitute*** *for Quality.*

Hughes

TOOL COMPANY

HOUSTON, TEXAS

New
LARKIN CEMENTROL* SHOE

A Major Step in the Progress of Oil Well Cementing

PURPOSE OF THE CEMENTROL SHOE:

The purpose of the Larkin Cementrol Shoe is to prevent the downward movement of cement below the casing shoe during and following the cementing operations, eliminating the possible cement sheathing of the face of the formation.

Many operators have found while drilling-in after casing was cemented that the cement had squeezed itself back into the producing formation and temporarily, if not permanently, damaged the productivity of the well. All manner of added difficulty and expense has been encountered putting the well on production; wall scraping, under reaming, shooting, acid jetting and cleaning out of such wells. Some were lost entirely.

At the request of and in conjunction with Engineers of oil companies that were experiencing trouble, Larkin began the task of developing a tool to overcome the difficulty. Many ideas were put forth, much experimentation done and many design changes. The final result is the Cementrol Shoe shown here—A tool that is tried and proved both in the laboratory and in the field. It may be your solution to some cementing problem.

HOW THE CEMENTROL SHOE WORKS:

The Cementrol Shoe acts as a conventional float shoe while casing is being run. The familiar Larkin Bakelite Guide and Valve Assembly provides this.

When casing reaches cementing depth a Bakelite ball is dropped and is pumped down slowly until it comes to rest in the seat of the internal Bakelite middle section in the Cementrol Shoe. Through keyhole shaped slots in the steel body of the shoe this middle section is pinned with shear pins to a sliding steel sleeve on the outside of the shoe. This sliding sleeve is in contact with the Packing Elements.

After the ball has seated pump pressure is continued, and before a pressure of 300 P.S.I. has been reached the internal Bakelite middle will have moved downward, forcing the external steel sleeve downward against the packing elements and expanding them firmly against the wall of the hole, thus packing off the casing on the outside. Pump pressure is continued until it reaches approximately 850 P.S.I., at which point the pins shear, the Bakelite moves further downward, opening side ports through which the well is cemented. Slips lock to prevent the external sleeve from moving upward, and the packer must remain expanded. The Bakelite ball and middle, bridge the casing on the inside, the packing element packs off on the outside, and no cement can pass to the formation below the Cementrol Shoe. After cement has set, the Bakelite mechanisms can be easily drilled out and no cement will be encountered below the shoe.

The Cementrol Shoe has the added advantage of centering the casing in the hole so that there will be an evenly spaced flow of cement slurry up around the pipe.

A baffle collar to stop the cement plug, yet allow passage of the bridging ball, can be furnished.

Larkin wishes to express here, sincere appreciation for the invaluable assistance and advice so freely given by the engineers and other personnel of oil companies who shared in the development of the Larkin Cementrol Shoe.

* Reg. U. S. Pat. Off.

LARKIN PACKER CO., INC.

ST. LOUIS, MO.

WAREHOUSES: Houston, Corpus Christi, Odessa, Shreveport, Tulsa, Great Bend, Wichita Falls

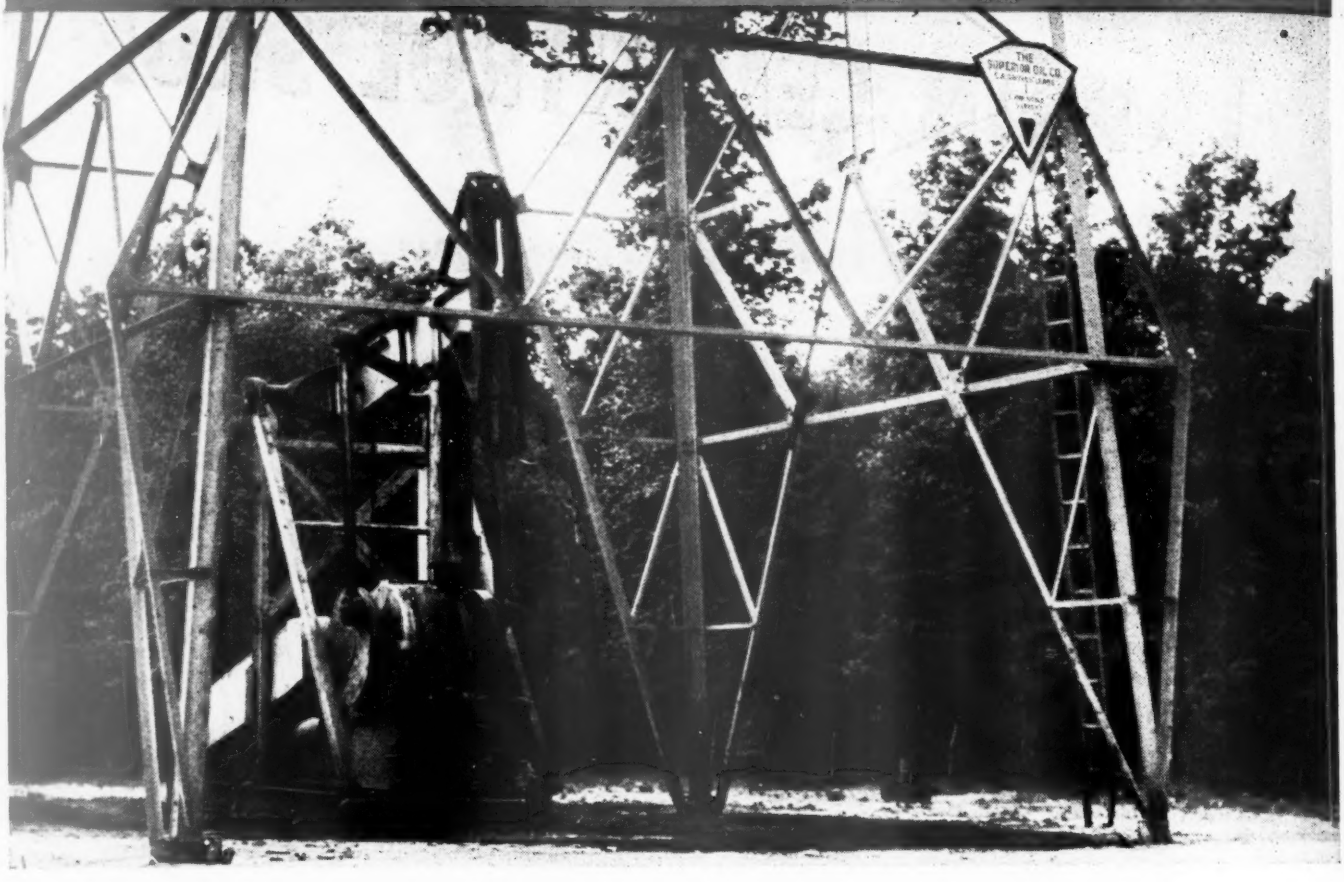
EXPORT: 74 Trinity Place, New York City

LARKIN

Texasteel Sucker Rods . . .

ELECTRIC STEEL

Help Set Deep Pumping Record!



Read the record of Superior Oil Co.'s C. A. Grove No. 1.

The Superior Oil Co. has probably set a new record for deep pumping with rods on their C. A. Groves No. 1 well 10 miles east of Canton in Van Zandt County, Texas . . . using TEXASTEEL Rods. Rods in use are 8,600' of ⅞" Grade A Texasteel Electric Steel Sucker Rods, pin and pin, with hardened and ground couplings, and one 15' x 1½" Texalloy Polished Rod.

Rods were run to a depth of 7,600' and pumping started at 15 strokes per minute using an air balanced pumping unit on a stroke of 66" and a 1¼" fluid packed pump, size 2" x 1¼"x10'. Pumping at this depth was continued 24 hours a day, 7 days a week for 30 days, when the pumping depth was lowered to 8,456' 2" and speed slowed to 12 strokes per minute. Pumping was then put on a 12 hours per day, 7 days per week basis, and after nine months the well is still pumping on a 66" stroke. Lease Superintendent reports highly satisfactory performance from rods.

Daily production of well is 60 barrels of 38.7 gravity oil with no water. The peak polished rod load is approximately 25,000 lbs.

The highly satisfactory performance of Texasteel Rods on this Superior well is typical of the service that you can get from Texasteel Rods in YOUR wells . . . because Texasteel Rods are manufactured from the steel of tomorrow . . . Electric Furnace Steel . . . steel that is amazingly resistant to corrosion and fatigue.

Texasteel Electric Steel Rods are available TODAY. Write our nearest office for quotations.

ELECTRIC STEEL **SUCKER RODS**

TEXASTEEL MANUFACTURING CO.

Houston, 217 West Bldg., Phone Charter 4-3301 • Kilgore, P. O. Box 916, Phone 1054 • Tulsa, 310 Thompson Bldg., Phone 2-2339

FORT WORTH, TEXAS

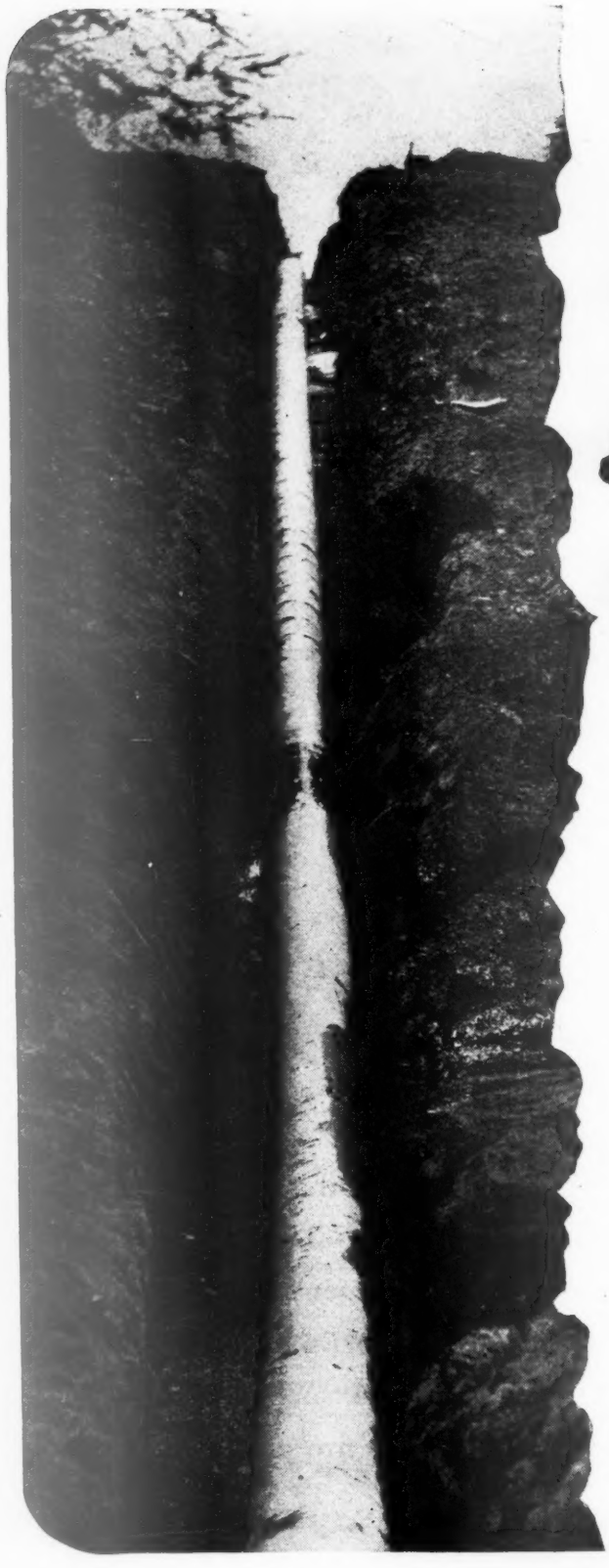
The Steel of Tomorrow Is Available Today

THIS . . . is the first civilian announcement of the war-born *blended multi-protein foaming agent* for highspeed extinction of gasoline, oil and other serious fires. The U.S. Navy uses this effective multi-protein foam extensively for preparedness—and for quickly extinguishing fires on shipboard and at shore bases. MEARLFOAM-5 yields the live, lasting foam with the tough, elastic water-retaining film. When split-seconds count—you can rely on MEARLFOAM-5 to put fire out fast—keep fire out, *permanently!*

Completely safe and non-corrosive—may be used in standard Mechanical Foam-Forming Equipment

FOAM ON FIRE OUT... Stays OUT!

THE MEARL CORPORATION
153 Waverly Place, New York 14, N.Y.



LAYS FAST, LOWERS COST

-because it's UNIFORMLY STRAIGHT

When you want speed in pipe line construction, don't underestimate the quality of *straightness* in Republic Electric Weld Line Pipe.

Republic Line Pipe is straight over its entire length. It makes pipe ends match up better for faster welding. It makes lines lay straight in the ditch. It helps get the job done sooner and saves on construction costs.

Many cost-wise oil country men prefer *line-proved* Republic Electric Weld Line Pipe, too, for its *Uniform Wall Thickness, Uniform Roundness and High Weldability* which help produce strong field welds quickly—for its *High Ductility* that saves time on the bends—for its *Long Lengths* that mean fewer welds and double-quick laying speed—for its *Freedom from Scale* that reduces line cleaning and valve replacement costs. More than 40,000 miles in service, installed during the past 15 years, have proved its dependability.

For line pipe that lays fast and lowers cost, always specify Republic Electric Weld Line Pipe.

REPUBLIC STEEL CORPORATION
GENERAL OFFICES • CLEVELAND 1, OHIO
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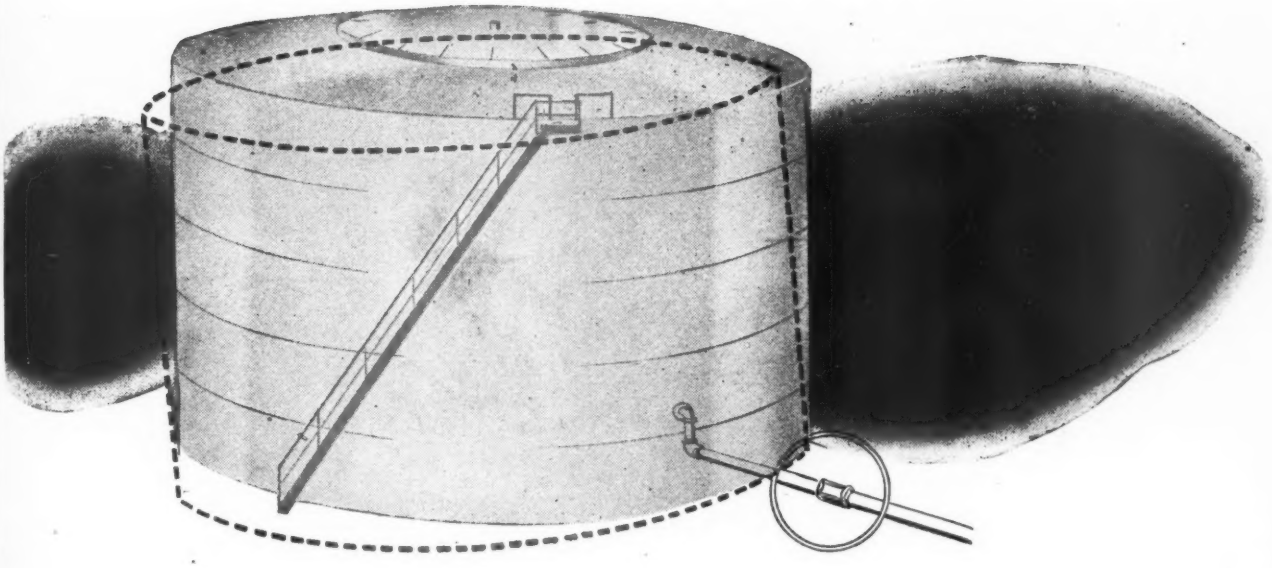
REPUBLIC
LINE PIPE
NORMALIZED CASING AND TUBING



When This Tank Settles...

Dresser Couplings Relieve Piping Stresses

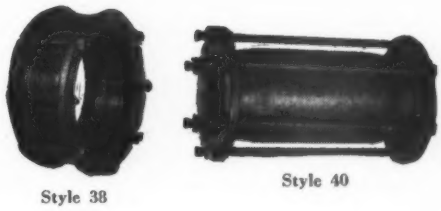
...AND STAY TIGHT!

Settling foundations, temperature changes, earth tremors and the like often displace tanks so that ordinary pipe connections are highly stressed, to the point of failure. Dresser Couplings have a resilient compressed gasket seal which "gives and takes" to relieve these stresses without loss of sealing power.

This is only one of the ways Dresser Couplings solve piping problems. Together with tightness under usual and unusual operating conditions, Dresser Couplings incorporate simplicity, flexibility, speed and ease of installation which give the most practical answers to many oil piping hookups. Send us your inquiries for any size, any quantity, any application.

Dresser Manufacturing Division, Dresser Industries, Inc., Bradford, Pa. Houston Office and Warehouse, 1121 Rothwell Street, Sec. 16, Houston, Texas; in Canada: Dresser Manufacturing Company, Ltd., 60 Front Street, West, Toronto, Ontario.

Dresser Couplings for Tank Connections



Style 38 Style 40

Style 38 is the standard Dresser Coupling, used where pipe-ends come fairly close together. For closures, or where excessive pipe pull is anticipated, use Style 40 Long Sleeves.

DRESSER COUPLINGS for Plain-End Pipe

WAR BOND MAN

— CLASS OF '63

Someday you'll want to see that boy, or girl, of yours off to college . . . and *right now* is not too early to start making plans.

Maybe your youngster, like so many other American boys, will work his way through school . . . but even in that case you'll want to be in a position to give him a little help if he needs it.

By what you put aside in War Bonds *today* you can help *make sure* he gets the same chance as other boys, *tomorrow*.

Chances are you're already on the Payroll Savings Plan. Saving as you've never been able to save before. This is fine not only for you, but for your country—*provided you keep on saving.*

But take your dollars out of the fight —and you will be hurting yourself, your boy's future, and your country.

Buy all the bonds you possibly can. Try to get even more than you ever have before. And remember this . . .

For every three dollars you invest today, you get *four dollars back when your Bonds come due.* You, and your boy, can use those extra dollars.

Make sure you get those Bonds! Hold on to them till they come due!

WILLIAMS BROTHERS CORP.

ENGINEERS CONTRACTORS

Oil — Gas — Gasoline — Water Pipe Lines and Pump Stations

NEW YORK • TULSA • ATLANTA • HOUSTON

★ *This is an official U. S. Treasury advertisement—prepared under auspices of Treasury Department and War Advertising Council* ★

Pipe Lines, Too, Are Helping Win The War

Like battleships, tanks and airplanes, pipe lines, too, are fighting mechanisms of World War Two. Without them neither the production lines on the home front nor the battle lines in foreign lands could be supplied with the petroleum products so essential to victory.

And the O. E. Dempsey organization has been "in the service" on practically every major pipe line project since Pearl Harbor. Fortunately, our more than twenty-five years experience, modern equipment, skilled field force and supervisors have equipped the Dempsey personnel to do an effective, constructive job. We will be pleased to receive consideration on any project you may have.

O. E. DEMPSEY CONSTRUCTION CO.

Oil and Gas Pipe Lines

2441 EAST INDEPENDENCE AVENUE
PHONE LD 431 OR 4-3943

TULSA 8, OKLAHOMA
P. O. BOX 3098

SHAFER "DE" 22000 BEARINGS

SELF-CONTAINED
SELF-ALIGNING
SELF-CENTERING
under heaviest loads and adverse operating conditions

Any experienced engineer recognizes that *most* bearing installations *must* encounter shaft misalignment and deflection . . . end and radial thrust and even heavy shock loads. And more and more engineers are recognizing that only Shafer ConCaVex Bearings have the design and construction that keep them free-rolling, self-aligning and self-centering under *all* such conditions at *all* times. For only Shafer Bearings combine the ball bearing and roller bearing construction . . . only Shafer Bearings combine the low rolling friction of a ball and the high load capacity of a roller. Only Shafer Bearings have such an outstanding record of service on the *tough* installations for the past 25 years. Ask the men who KNOW. SHAFER BEARING CORPORATION, 1426 West Washington Blvd., Chicago 7, Illinois.

The Basic Shafer Idea

Shafer ConCaVex Self-Aligning Bearings combine the advantages of both ball and roller bearings. A Shafer Bearing utilizes the effective contact area of a ball many times its size . . . providing automatic end-thrust absorption, superior shock resistance and long life.

1. SHAFER "DE" 22000 SERIES
The self-contained bearing, preadjusted, ready to install, easy to install. Has one piece outer race, two rows of rollers and single inner race for compactness. Maximum capacity.

2. SHAFER DOUBLE ROW BEARING ASSEMBLY
for building into machines, power transmission equipment, etc. Two outer races, two roller assemblies. A single inner race.

3. SHAFER SINGLE ROW BEARING ASSEMBLIES
One outer race, one row of rollers, one inner race. Self-aligning with radial and thrust load capacity.

SHAFER ConCaVex SELF ALIGNING BEARINGS
Reg. U. S. Pat. Off.

SELF ALIGNING ROLLER BEARINGS

"Grab a hot hand wheel once and you'll change design in a hurry!"

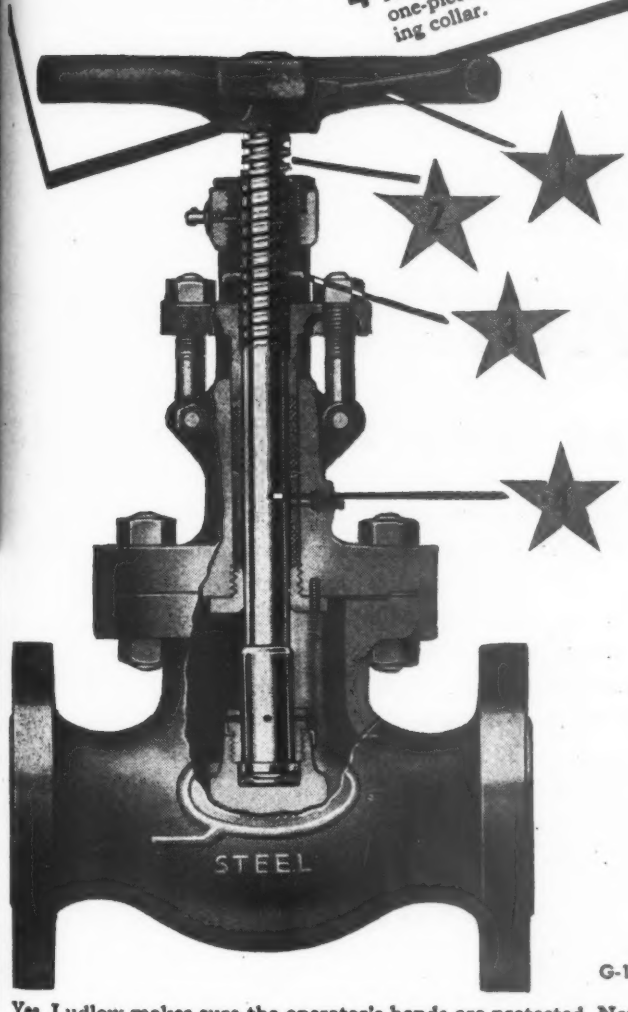
Right! That's why LUDLOW STEEL GLOBE VALVES have:

1 A malleable, non-slip hand wheel — with special spokes to minimize heat conduction.

2 A stem with Acme thread form to permit wear compensation.

3 Convenient shelves to hold stuffing-box follower out of your way during repacking.

4 A stem complete in a one-piece unit, including collar.



G-1

Yes, Ludlow makes sure the operator's hands are protected. Not only that, in Ludlow Cast Steel Globe Valves you'll find every practical feature for efficient, enduring operation at low maintenance cost. They're built to take punishment — while delivering the top performance for which all Ludlow Valves are famous. . . . Write today for complete catalogs.

The LUDLOW VALVE SINCE 1866 MFG·CO·INC·TROY·N·Y·

MID-CONTINENT SUPPLY COMPANY • FORT WORTH, TEXAS

Win your Battle AGAINST COKE with AIRETOOL TUBE CLEANERS

Overpower the enemy of refinery efficiency —coke and other deposits in tubes—with powerful, efficient, easier-to-use Airetool Tube Cleaners. This is the tube cleaner with the 28% more powerful motor that can be loaded down to 50 r.p.m. without stalling, with the wide variety of new form cutters that last longer, remove the severest deposits without tracking. No wonder it's easier and quicker to clean tubes with Airetool. Airetool Cleaners are made for tubes ½ to 24 in. I.D.; straight or curved.

AIRETOOL TUBE EXPANDERS

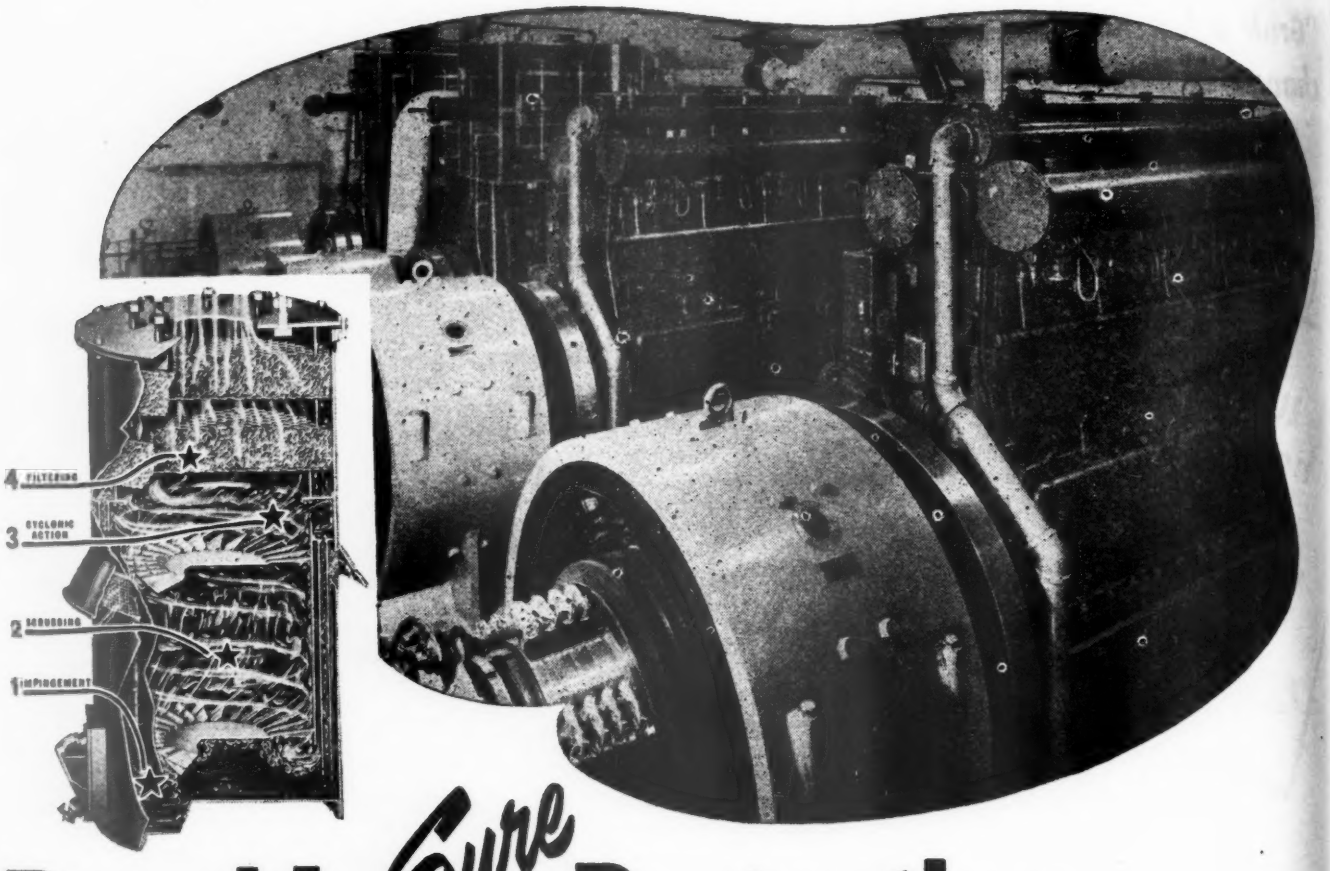
Developed to meet the demands of modern oil refinery technology for properly rolled joints. Careful construction by expert workmen of finest heat treated alloy steels assures longer life. Made in a wide variety of sizes with universal or right angle drives.

HELPFUL BULLETINS

that tell all about Airetool Tube Cleaners, Expanders and other refinery specialties, their use, selection and care are "yours for the asking." Contains valuable helpful information.

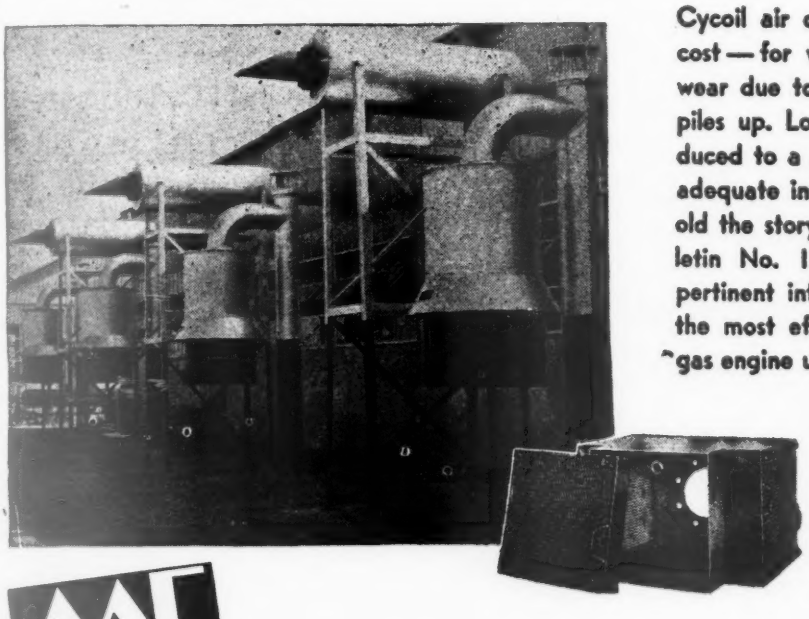
AIRETOOL MANUFACTURING COMPANY

Airetool & Yost-Superior Factory Buildings
SPRINGFIELD, OHIO



Provide *Sure* Protection

AGAINST EXCESSIVE WEAR AND BREAKDOWNS



Cycoil air cleaner protection is cheap at many times its cost — for when break downs occur caused by excessive wear due to the abrasive action of dust — expense really piles up. Losses caused by shut downs for repair are reduced to a minimum if power equipment is provided with adequate intake air cleaning. Whether engines are new or old the story is the same. — May we send you Cycoil Bulletin No. 130-D which gives engineering data and all pertinent information? Cycoil is universally recognized as the most efficient air cleaner yet devised for Diesel and gas engine use.

PROTECT COMPRESSORS, TOO!

Type OC-H filters are ideal for compressor service. Come as complete assemblies of viscous impingement type cells and housings. Installation consists merely of bolting housings to flange on air intake pipe. Send for Bulletin 130-D for complete information.

AAF

AMERICAN AIR FILTER COMPANY INC.

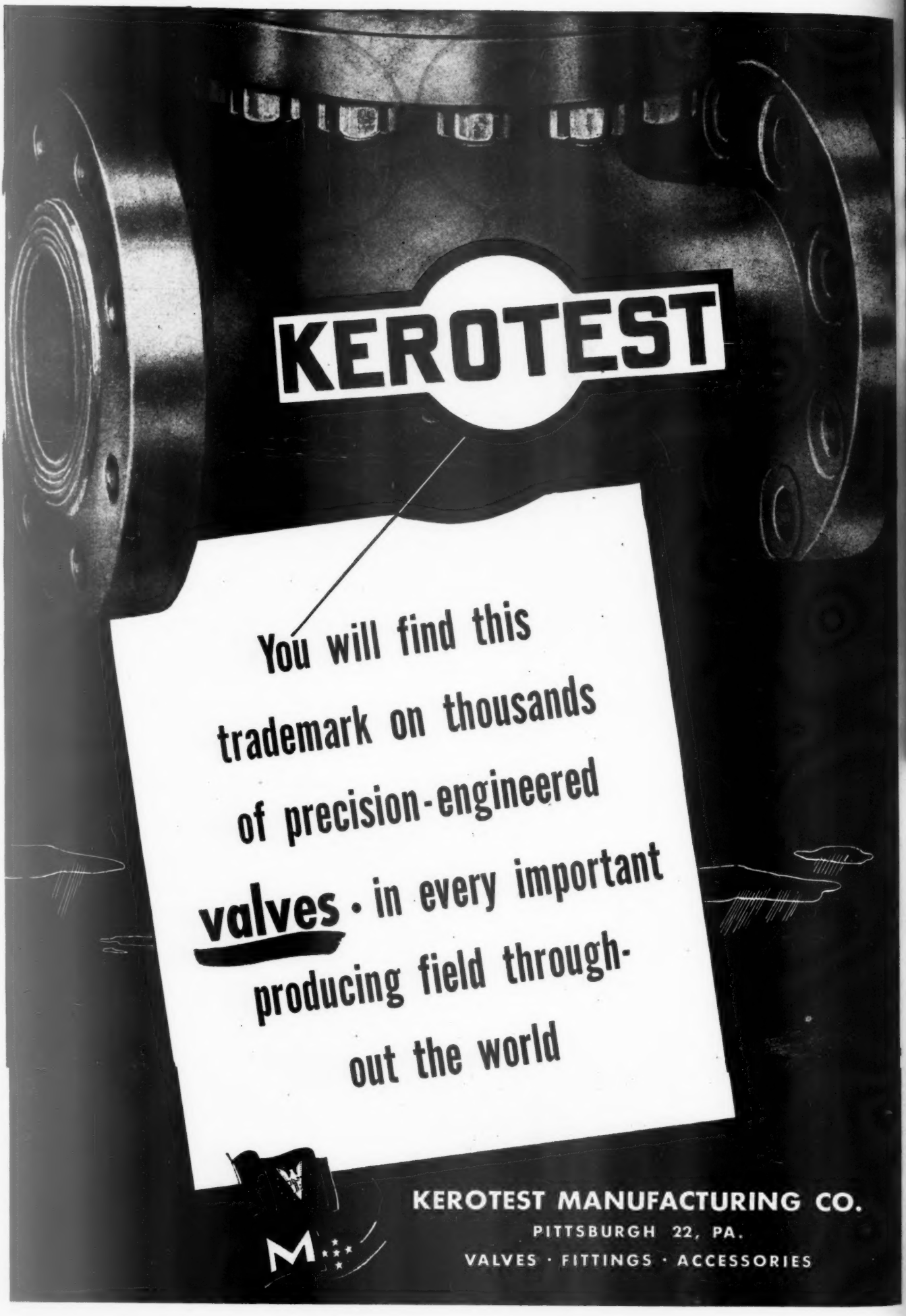
INCORPORATED

384 Central Avenue, Louisville 8, Ky.—In Canada, Darling Bros., Ltd., Montreal, P. Q.

THE CHAPMAN PRODUCTION LINE IS CERTAINLY HUMMING THESE DAYS!
YES, AND EVERY VALVE THAT ROLLS OFF THE LINE STILL HAS THE SAME CHAPMAN "CUSTOM-MADE" QUALITY!
CHAPMAN 600 STEEL

Chapman Steel Valves roll off the production lines in greater quantities than ever before. Yet, every valve has a precision rating equal to that of a custom-made unit—meeting *or exceeding* standard specifications. All metals are developed and produced in the Chapman foundries under strict metallurgical control—a prime reason why Chapman Steel Valves stand up under severest war usages.

THE CHAPMAN VALVE
Manufacturing Company
INDIAN ORCHARD, MASSACHUSETTS


KEROTEST
You will find this trademark on thousands of precision-engineered valves • in every important producing field throughout the world
KEROTEST MANUFACTURING CO.
PITTSBURGH 22, PA.
VALVES · FITTINGS · ACCESSORIES

You Receive more H.P. hours per $ with dependable LE ROI

Oil Field Engines *because*

1. They are built by a manufacturer *specializing exclusively in the heavy-duty industrial field.*
2. They are designed for your *specialized power requirements* in each of the three main branches in the oil industry: drilling, oil well pumping, and pipe line service.
3. They are *sold and serviced by a network of specialized distributors* serving the oil industry exclusively.

These two RXIV 8-cylinder Le Roi Engines, installed at Mansfield, Texas, pump approximately 30,000 barrels of fluid daily over a distance of 20 miles.

Only from Le Roi can you get this winning combination — backed up by years of successful experience in the oil fields. The performance record of Le Roi Engines is your assurance of creditable results when you, too, select Le Roi Engines for drilling, well pumping, or pipe line service.

LE ROI MILWAUKEE

★ TURN THE PAGE

For dependable, surging power to drill *deep* oil wells . . . you need LE ROI DRILLING ENGINES

It has been the experience of many successful deep-well drillers that, in spite of almost continuous operation, Le Roi heavy-duty engines continue to exceed their expectations in flexibility and economy.

You can depend on Le Roi engines for low-cost, long-life, trouble-free service, and flashing power that gives you lasting satisfaction. They're designed and built especially for this type of rugged service. All over the world they are proving their ability to perform dependably wherever tough conditions test soundness of design and quality of materials and workmanship.

Le Roi engines are available for all types of oil field service in sizes from 4 to 400 H.P. — utilizing gasoline, natural gas or butane. *See your nearby Le Roi distributor.*

LE ROI MILWAUKEE

LE ROI COMPANY, 1766 S. 68th St., Milwaukee 14, Wis. • Branch and Warehouse: Tulsa, Oklahoma. Branch Office: Birmingham, Alabama. *Distributors* — Western Machinery Co., St. Louis, Mo., Centralia, Ill. • General Machine & Supply Co., Wichita Falls, Odessa, Texas • Le Roi Rix Machinery Co., Los Angeles, Calif. • Hafer Engine Service, Reed City, Mich. • Industrial Power Units, Inc., Casper, Wyo. • Carson Machine & Supply Co., Great Bend, Kansas • Southern Engine & Pump Company, Houston, Dallas, Kilgore, Alice, San Antonio, Texas.

"IMPROVEMENT...the key," *he says*

Look, "L. G.," how recourse to the Lincoln "Shield-Arc" Welder provides the key to ***better refineries at lower cost.***

Key to a Better Gasoline Plant

THE "Job Selector" of the Lincoln "Shield-Arc" Welder permits selection of the TYPE of welding arc . . . a predetermined welding characteristic . . . to match the job. Its Current Control provides any desired amperage over a wide range. Both selectors are Self-Indicating for KNOWN results . . . unmatched speed and ease of welding at all times.

HENCE: This simplification of arc welding procedure assures ***higher quality welds*** at ***lowest welding costs*** . . . makes possible a ***wider use of arc welding*** for better and better refinery construction . . . for better and better petroleum products at lower and lower cost.

Full details on the "Shield-Arc" Welder with easy-to-understand facts about its Dual Continuous Control in Bul. 412. Free on request.

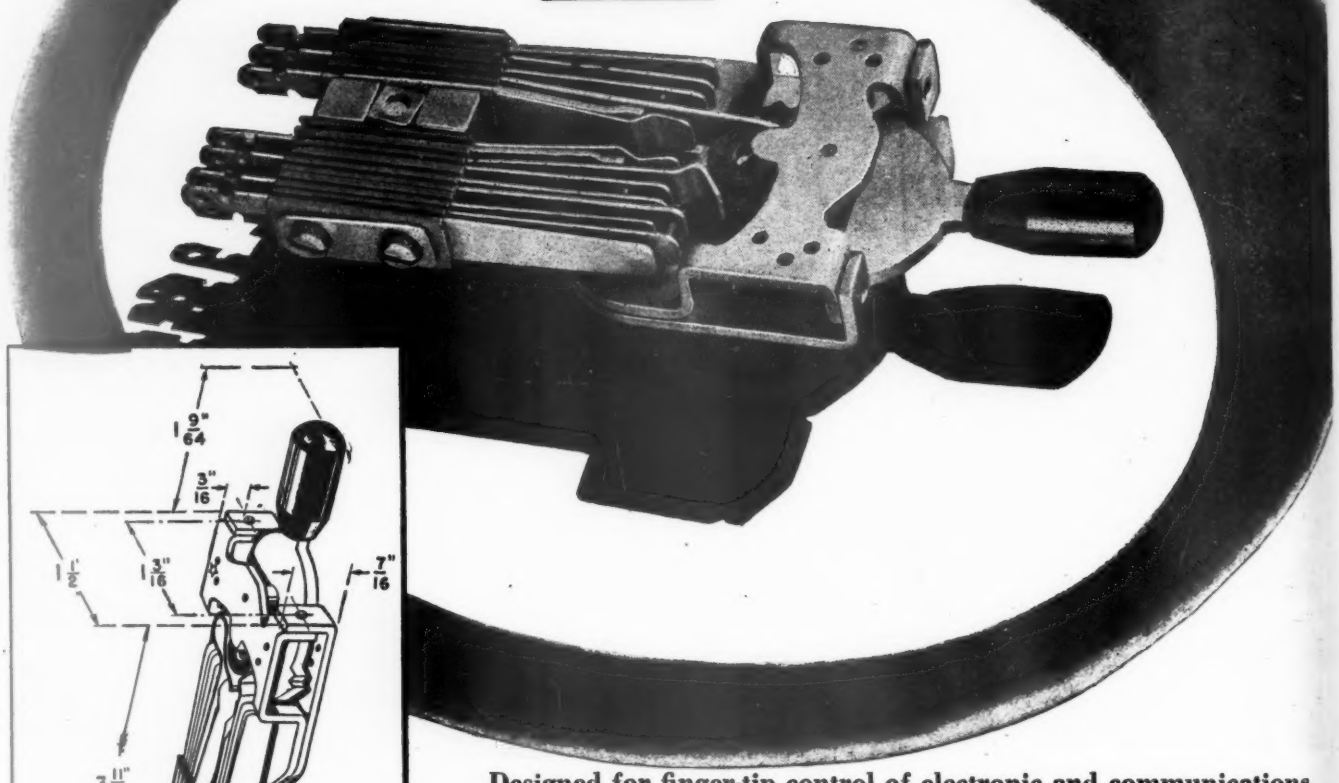
THE LINCOLN ELECTRIC COMPANY • DEPT. D-2 • CLEVELAND 1, OHIO

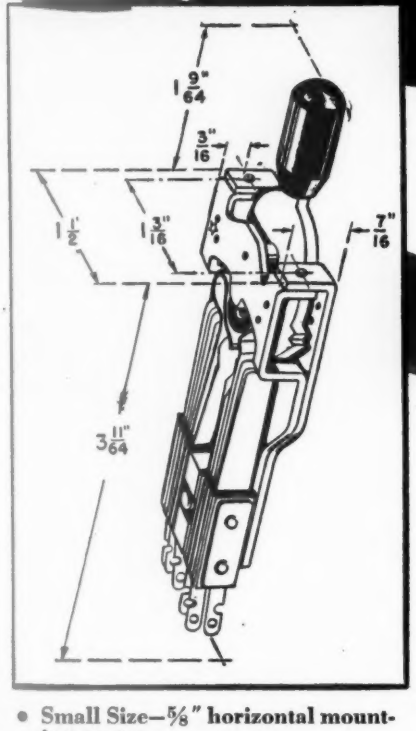
America's greatest natural **recourse**

ARC WELDING

The Little GIANT

FEDERAL'S *New* LEVER KEY





- Small Size—⅝" horizontal mounting centers.
- Large Spring Capacity — 18 springs; over 500 possible combinations.
- Palladium Contacts . . . Nickel Silver Springs.
- High-Quality Phenolfibre Insulation.
- Universal Cam — 1 or 2 way — locking or non-locking.
- Free-Moving Roller . . . Positive Snappy Action.

Designed for finger-tip control of electronic and communications equipment where size is important, the FTR-810 Series Lever Key occupies less than half the horizontal mounting space required for older types.

And at the same time, its eighteen nickel-silver springs and low-resistance palladium cross-bar contacts permit more than five hundred possible switching combinations.

High-quality phenolfibre insulated throughout, the overall simplification in design has resulted in a more rugged, dependable lever key with a positive, snappy action that once set — stays set.

The universal cam has an unusually long bearing surface for smooth action and long life . . . for either locking or non-locking operation . . . one or two-way, simply by a change in position of the stop pins.

Here is another compact component by Federal with a wide variety of applications in control circuits, and another reason to see Federal first for electronic and communications equipment.

FEDERAL TELEPHONE AND RADIO CORP. FTR

Federal Telephone and Radio Corporation

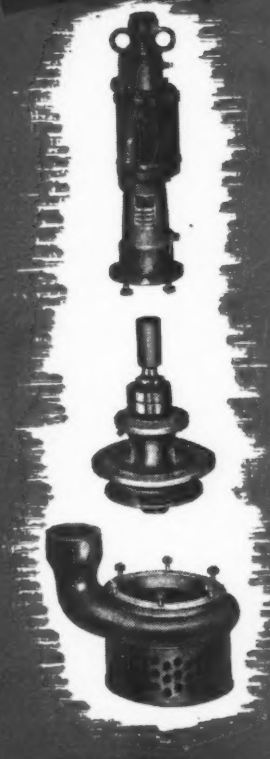
A Unit of International Telephone & Telegraph Corporation

Associate I&T

New Jersey

BYRON JACKSON

Pneumatic Sponge



BYRON JACKSON PNEUMATIC SPONGE CONSTRUCTION DETAIL

Impeller is a two-port, non-clogging type, of heat treated Meehanite affixed to a stainless steel shaft, supported by heavy, sealed, grease lubricated, duplex thrust and radial ball bearings. A renewable bronze wearing, matching the impeller, is inserted within the suction cover.

Volute case, including suction and shaft covers, are of semi-steel. Connector between air motor and pump is of Meehanite and the steel studs, connecting the flanges, are provided with bronze nuts. A perforated steel plate attached to pump below the case serves as a screen to exclude gravel or debris that cannot be passed through pump.

Designed for pumping heads to 150 feet, in single stage, and 300 feet in two stages, the Byron Jackson Pneumatic Sponge finds wide application for use in refineries, on tank farms and in chemical plants for pumping out ditches, pits, tanks, sumps, basements, manholes or other similar applications where the pumped fluid contains a heavy percentage of solids.

Built either as a single stage unit, or in two stages, for series operation, the Pneumatic Sponge is a centrifugal pump, driven by a rotary air motor, operating on compressed air at pressures from 70 to 100 psi, suitable for operation in any position.

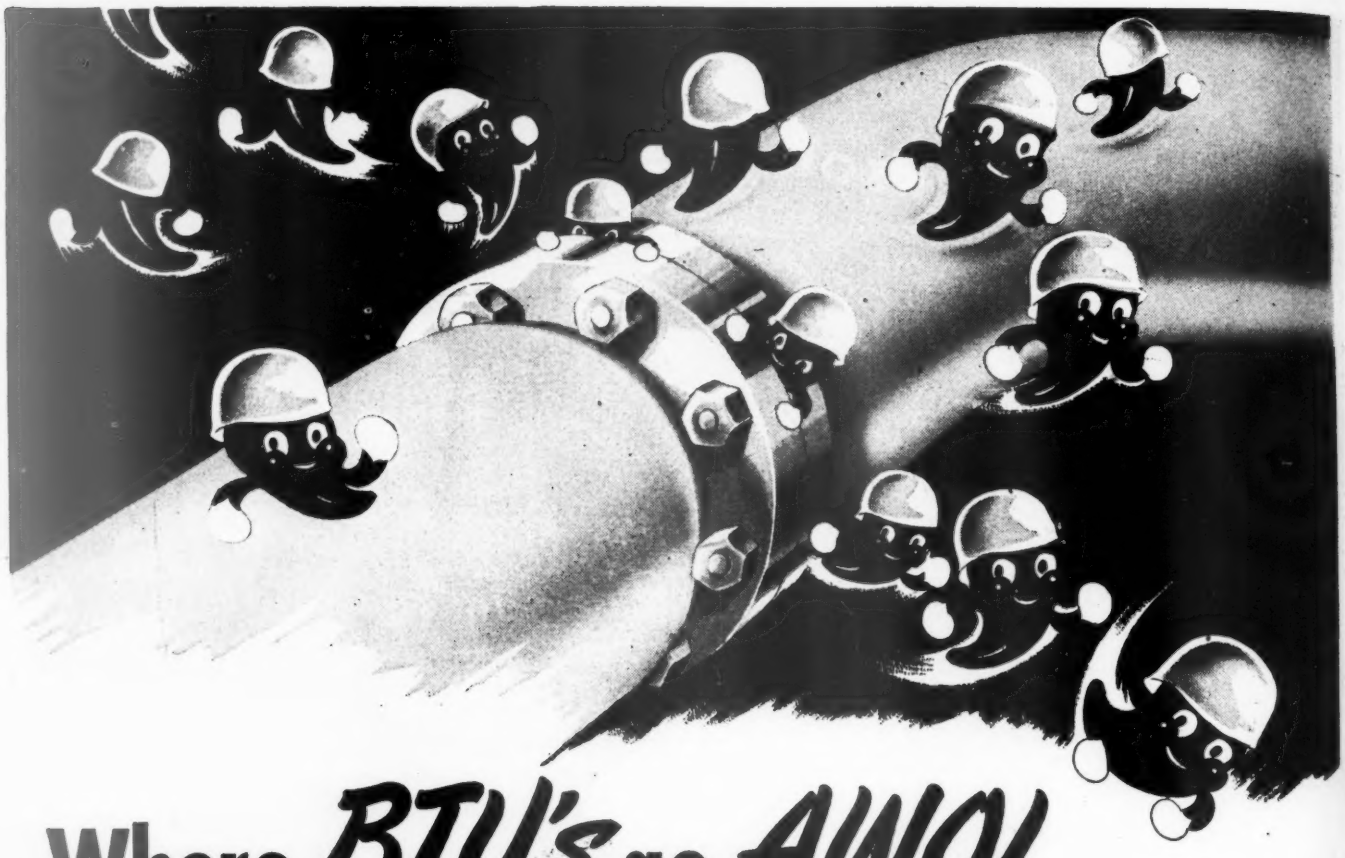
Compact, ruggedly constructed, yet light in weight, the sponge pump is quickly and easily moved from place to place; can be dismantled or converted from individual to parallel or series operation in minimum time and with minimum effort, without the possibility of misalignment.

Motor is equipped with a governor and variable speed control, thereby permitting regulation to suit particular conditions of the job.

Two standard sizes are available: 2½" in single or as a two stage unit and a 3" single stage low head unit. Write today for new Sponge Pump Bulletin No. 44-7035. Just off the press.

BYRON JACKSON CO.

Houston • Los Angeles • New York



Where BTU's go AWOL

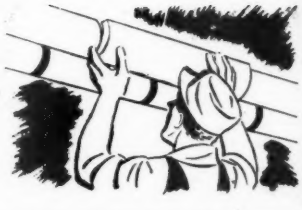
NATIONWIDE DISTRIBUTION—Warehouse stocks of the broad Carey Line provide service regardless of job location.

CAREY INSULATION ENGINEERING SERVICE makes available the knowledge and experience of leading authorities.

IT'S costly . . . the way those pesky BTU's keep trying to sneak off the job. For example: one pair of bare, 10-inch flanges at 350° F. can waste a ton of coal a year.

Carey Industrial Insulations keep BTU's where they belong . . . on the job. Carey makes a broad line of asbestos, magnesia and rockwool insulations . . . in forms that make either ordinary or tricky jobs fast, economical, dependable and efficient.

Put your insulation problems up to Carey Insulation Engineers. They're ready to help you with expert guidance based on more than 70 years experience in industrial insulation. Consult your nearest Carey branch or write direct.



TRAINED ERECTION AND SERVICE CREWS "make sure" the job is done right.

BROAD LINE FROM ONE SOURCE. No need to compromise with desired results. You get the *right* insulation for the job.

THE PHILIP CAREY MANUFACTURING CO.
LOCKLAND, CINCINNATI 15, OHIO

Carey

IN CANADA: THE PHILIP CAREY CO., LTD.
OFFICE AND FACTORY: LENNOXVILLE, P. Q.

Careyduct • Industrial Insulations • Rock Wool Insulation • Asbestos Shingles and Siding • Asphalt Shingles and Roofings
Built-up Roofing • Roof Coatings and Cements • Waterproofing Materials • Asphalt Tile Flooring • Pipeline Felt
Expansion Joint • Asbestos Wallboard and Sheathing • Corrugated Asbestos Roofing and Siding • Miami-Carey Bathroom Cabinets and Accessories

Announcement

It is with pleasure we announce the purchase of the pipe-line equipment division of the Cardwell Manufacturing Company, Inc., Wichita, Kansas.

For the present, this equipment will be manufactured exactly as it has been in the past by the Cardwell Manufacturing Company. At the earliest possible date, we plan to make important changes for the improvement of all models.

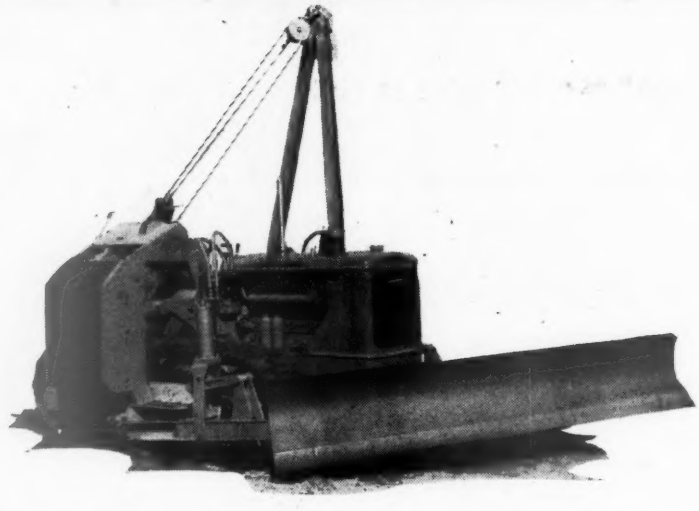
This equipment will continue to carry the trade name of "Cardwell" and will be marketed through "Caterpillar" distributors. In the near future, we will be in a position to make prompt delivery of any size sideboom for current model tractors. Prompt and efficient parts service is being rendered for all equipment in the field.

For complete information, prices and delivery dates on sidebooms, backfillers and accessories, see your "Caterpillar" dealer; or write us direct.

THE SUPERIOR EQUIPMENT CO.
Bucyrus, Ohio

O. E. (Ted) Murrey
Manager of Sales

DOUBLE-DUTY EQUIPMENT *Speeds up the Job!*



This "Cardwell" sideboom with the blade backfiller (Brosidozer) is one of the busiest pieces of equipment in any pipe-line spread.

The blade can be used for clearing right-of-way, the sideboom handles and lays pipe and the blade can then be used for backfilling the ditch. Hydraulically operated by sturdy, fast actuating rams, the blade is controlled by a single lever.

The blade backfiller (Brosidozer) is available with "Cardwell" sidebooms mounted on "Caterpillar" D4, D6 and D7 tractors.

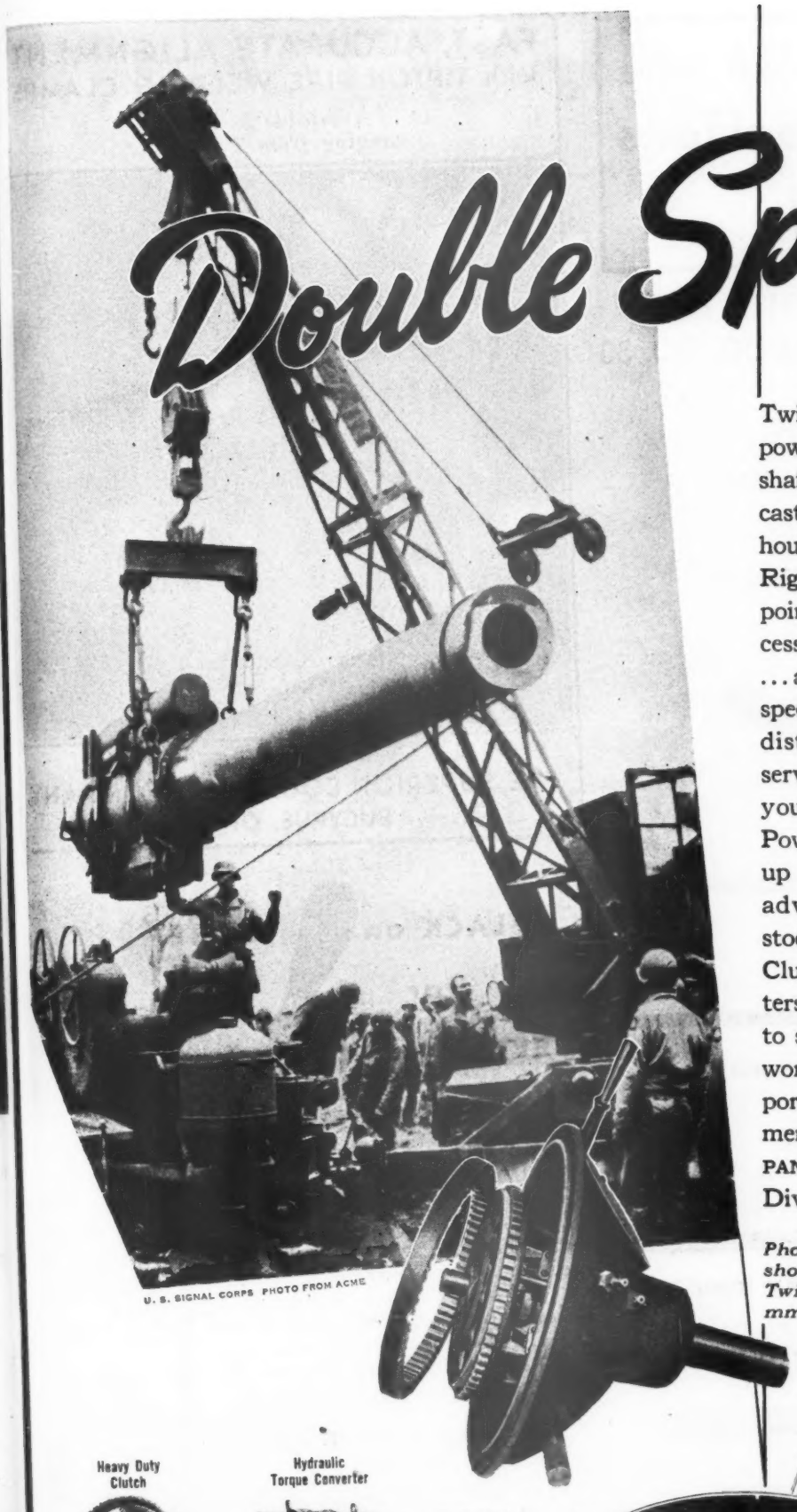
See your "Caterpillar" dealer for complete information and prices.

BROS BOILER & MANUFACTURING COMPANY

Bulldozers • Heaters • Circulators • Road Rollers • Snow Plows

Minneapolis, Minnesota

Double Speed-up



U. S. SIGNAL CORPS PHOTO FROM ACME

Twin Disc Power Take-offs—clutch power take-off units complete with shafts and bearings mounted in rigid cast iron housings—fit standard S.A.E. housing sizes from S.A.E. 6 to No. 00. Rigidly maintained tolerances at every point in production eliminate any necessity of fitting parts during assembly . . . a definite time saving. This not only speeds up the assembly line but is a distinct advantage when post-sale service becomes necessary. Thus, when you specify Twin Disc *Standard* Power Take-offs, you not only speed up your assembly, but you take full advantage of the *standard* parts stocks maintained by the Twin Disc Clutch Company in 37 industrial centers in the United States and Canada to speed up field service . . . prevent work interruptions or delays in transportation of vitally needed replacement parts. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin (Hydraulic Division, Rockford, Illinois).

Photo at left was taken on Italian front; shows Thew Moto-Crane equipped with Twin Disc Power Take-off lowering a 240 mm. howitzer into position.

SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918

Selections from the

"Most Complete Line of Tongs in the World"

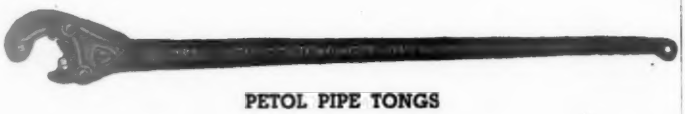
PETOL TOOLS · TITAN TOOLS

WRITE FOR CATALOG NO. 50

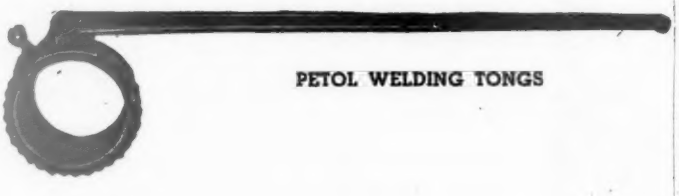
28 TYPES
A TYPE FOR EVERY PURPOSE

290 SIZES
A SIZE FOR EVERY REQUIREMENT

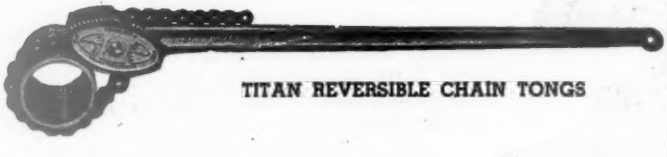
PETOL STABBING TONGS



PETOL PIPE TONGS



PETOL WELDING TONGS



TITAN REVERSIBLE CHAIN TONGS

TITAN PIPE TONGS

Gearench Mfg. Company

HOUSTON, TEXAS, U. S. A.

EXPORT: 74 Trinity Place, New York, N. Y.

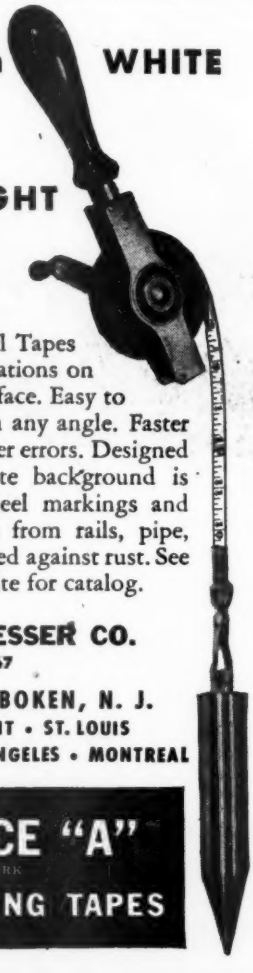
FAST, ACCURATE ALIGNMENT
with **TIPTON PIPE WELDING CLAMPS**

Available in sizes ranging from 2" to 26"

Distributed by

THE SUPERIOR EQUIPMENT COMPANY
BUCYRUS, OHIO

BLACK on WHITE for BETTER SIGHT



WYTEFACE "A" Steel Tapes have *raised* black graduations on a crack-proof white surface. Easy to read in any light, from any angle. Faster measurements with fewer errors. Designed for hard service. White background is protected by raised steel markings and rims. Resists abrasion from rails, pipe, rocks, concrete. Protected against rust. See your supply house. Write for catalog.

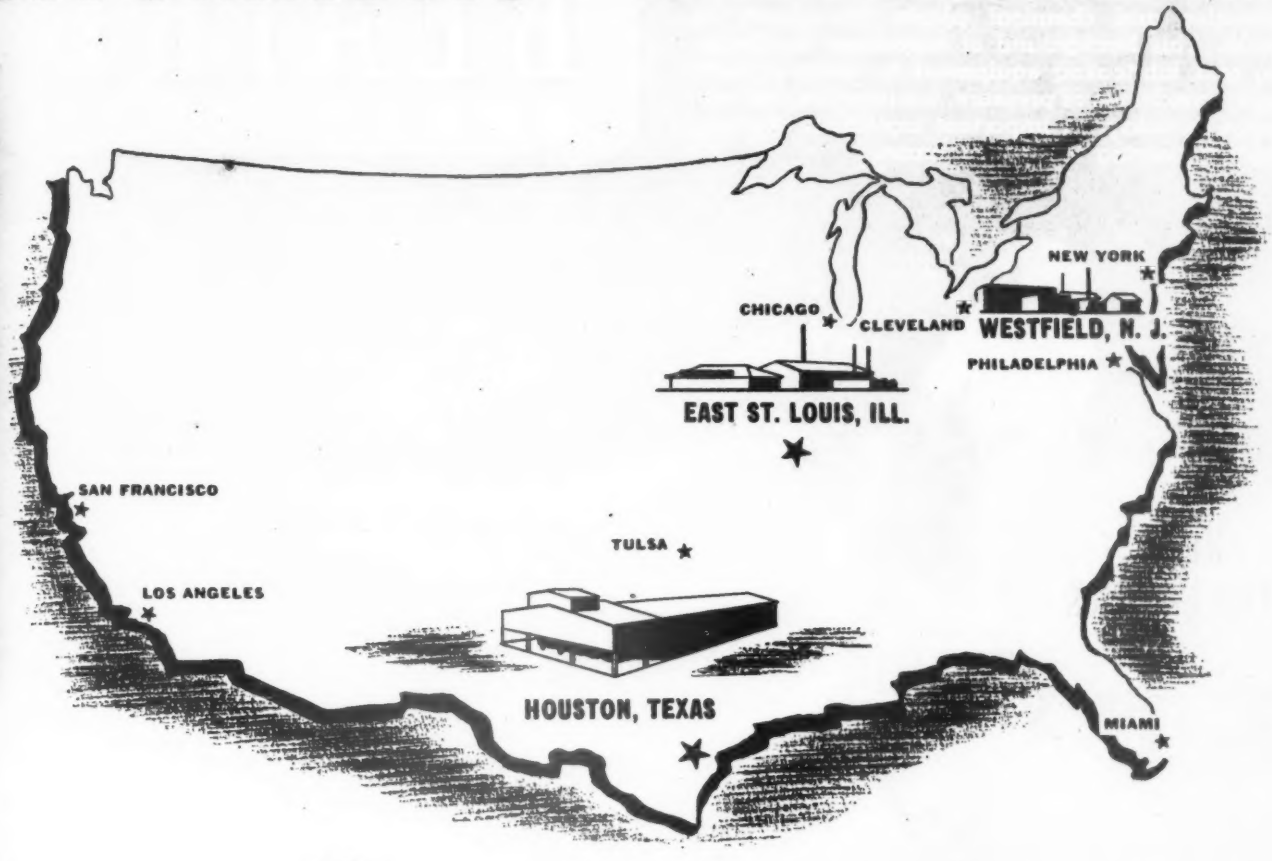
KEUFFEL & ESSER CO.
EST. 1867

NEW YORK • HOBOKEN, N. J.
CHICAGO • DETROIT • ST. LOUIS
SAN FRANCISCO • LOS ANGELES • MONTREAL

K&E
Drafting Reproduction Surveying Equipment and Materials Slide Rules Measuring Tapes

WYTEFACE "A"
TRADEMARK
STEEL GAUGING TAPES

BITUMASTIC IS IMMEDIATELY AVAILABLE



3 PLANTS AND 10 DISTRICT OFFICES STRATEGICALLY LOCATED

Three Wailes Dove-Hermiston manufacturing plants are strategically located to assure prompt delivery of Bitumastic Enamels and Industrial Coatings. Serving the East is the plant at Westfield, New Jersey. The one at East St. Louis, Illinois, handles the pipe line construction needs of the Middle West and West, and the new Houston plant serves the oil and gas field section of Texas and the Southwest.

Full stocks of the various grades of hot applied Bitumastic Enamels, as well as the cold applied Bitumastic Industrial Coatings, are carried at all three locations.

Sales and engineering services are also available through the 10 offices shown on the above map.

Today Bitumastic coatings are used in every major industry where effective corrosion protection is required for plants, structures and equipment. Write or phone the nearest Wailes Dove-Hermiston office.

HOT COATINGS: Bitumastic Regular Enamel, Bitumastic XXH Enamel, Bitumastic 70-B Enamel, Bitumastic Priming Solution and 70-B Priming Solution.

COLD APPLIED COATINGS: Bitumastic Black Solution, Bitumastic Super-Service Black, Bitumastic No. 50, Bitumastic Tank Solution, Bitumastic Hi-Heat Gray.

WAILES DOVE-HERMISTON
CORPORATION
WESTFIELD, NEW JERSEY

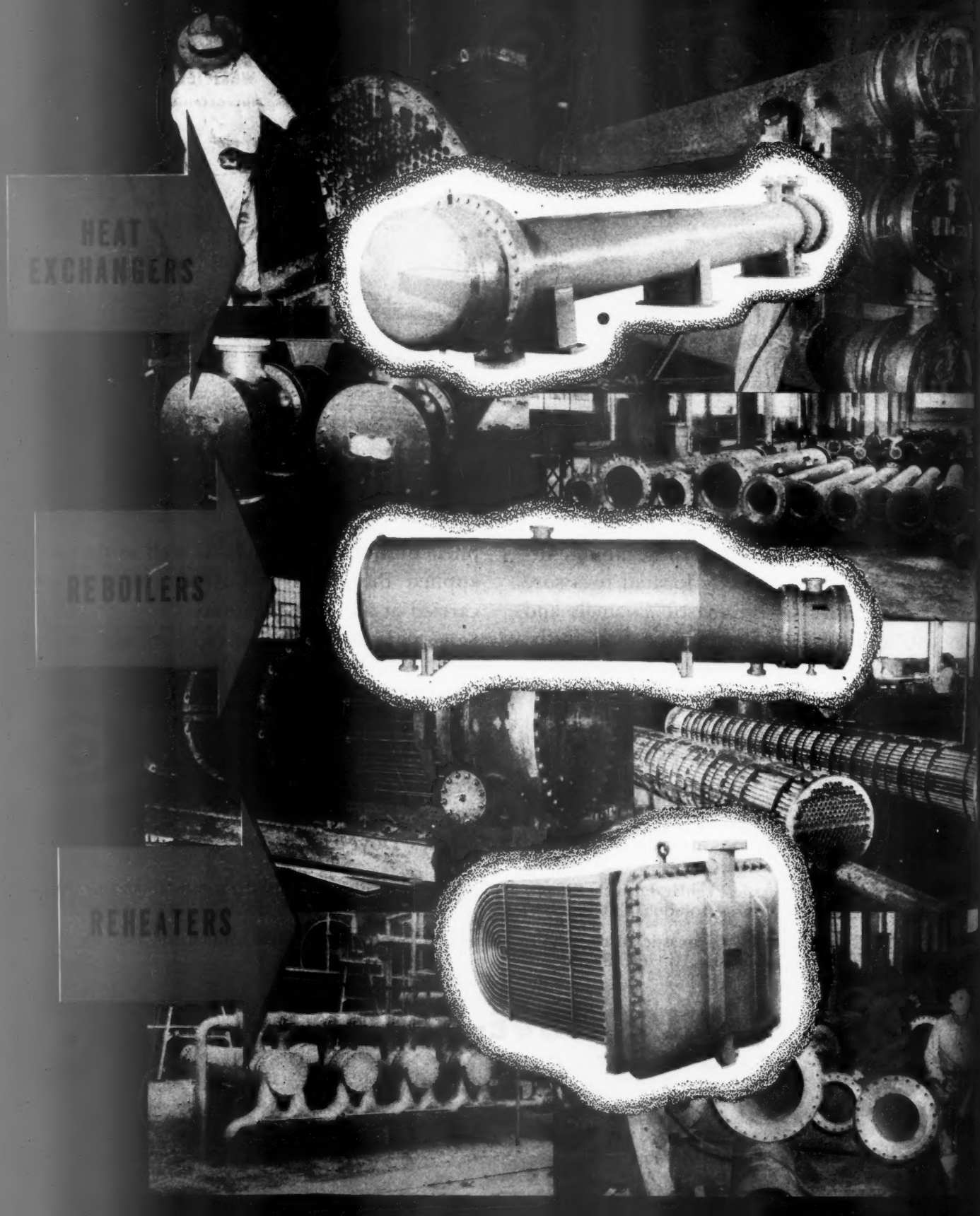
New York • Philadelphia • Cleveland • Chicago • Houston • Tulsa • Miami • San Francisco • Los Angeles

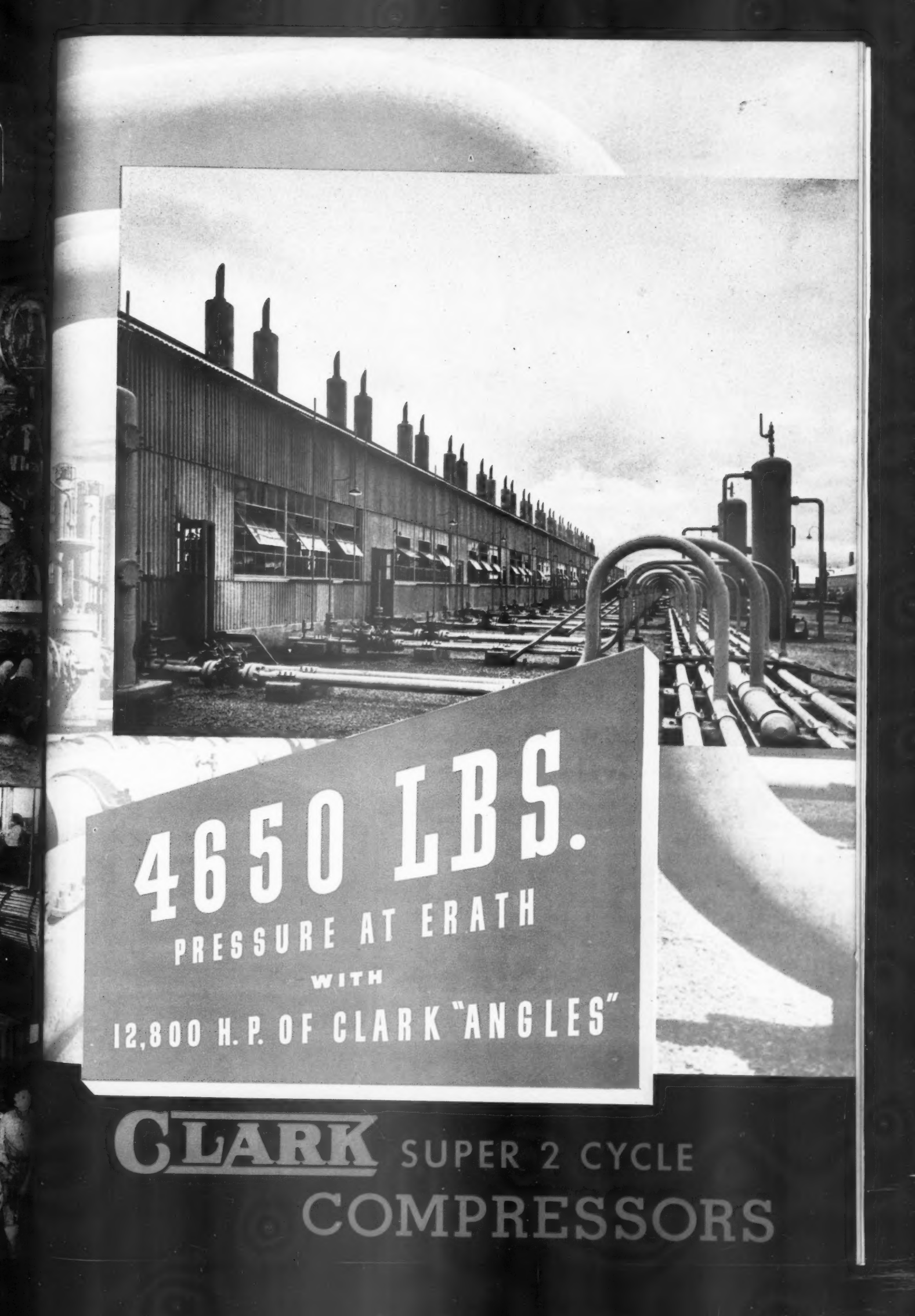
FOR MORE THAN a quarter-century Beaird has served the petroleum and chemical industries. Hundreds of Beaird-made vessels and exchangers of many types are in service in refineries and chemical plants throughout the world. This background of experience in designing and fabricating equipment for service under many conditions of pressure, temperature and corrosion is today an important ingredient of every product bearing the Beaird name.

SINCE 1918

BEAIRD

SHREVEPORT




4650 LBS.
PRESSURE AT ERATH
WITH
12,800 H.P. OF CLARK "ANGLES"
CLARK SUPER 2 CYCLE
COMPRESSORS

16 Clark Compressors at the new Erath Unit, shown above, provide 4650 lbs. pressure.

MORE GAS TO THE SAND AT HIGHER PRESSURE WITH 12,800 H. P. OF CLARK "ANGLES"

The new cycling plant of the Erath Unit at Erath, Louisiana, where the Texas Company is the operator, breaks all previous records by returning gas to the formation at 4650 lbs. pressure.

The design and manufacture of the 16 Clark "Angle" Compressors for this job called for precision engineering and workmanship of the highest order. Compressor cylinders were designed to meet the exact operating conditions to which they would be subjected. Extremely close tolerances had to be maintained.

The basic economy and dependability of the Clark 2 Cycle "Angle" is demonstrated once more in the most modern type of plant.

CLARK BROS. CO., INC. • OLEAN, N. Y.

New York · Tulsa, Okla. · Houston, Tex. · Chicago
Boston · Los Angeles · London · Buenos Aires

CLARK COMPRESSORS CUT COSTS

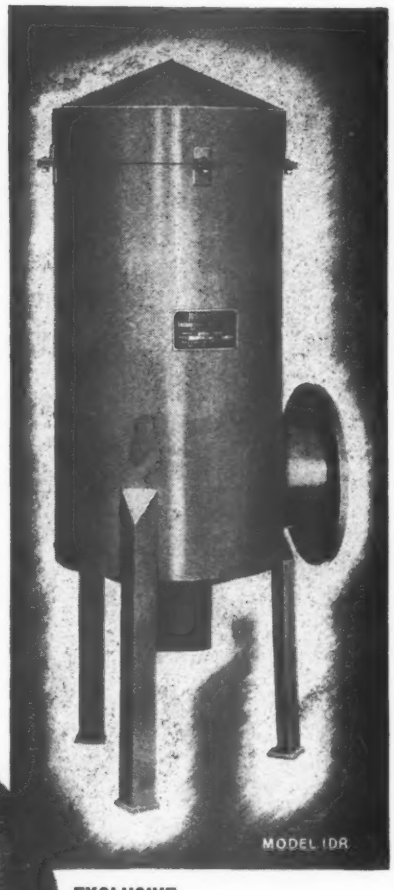
1. Cut fuel costs—Reason: Super 2 Cycle fuel injection.
2. Cut transportation and erection costs—Reason: lighter weight—more easily installed.
3. Cut foundation and floor space costs—Reasons: compact "Angle" design—inherent balance.
4. Cut maintenance costs—Reason: extreme mechanical simplicity.

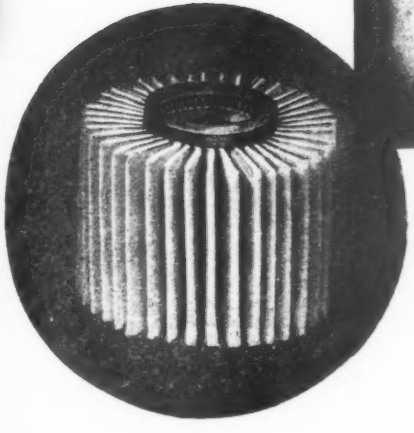
CLARK

ONE OF THE DRESSER INDUSTRIES

SETS THE PACE IN COMPRESSOR PROGRESS

new STAYNEW Intake Air Filter





EXCLUSIVE RADIAL FIN CONSTRUCTION PROVIDES:

- ★ More Filtering Area
- ★ Greater Efficiency
- ★ Less Resistance
- ★ Less Frequent Servicing

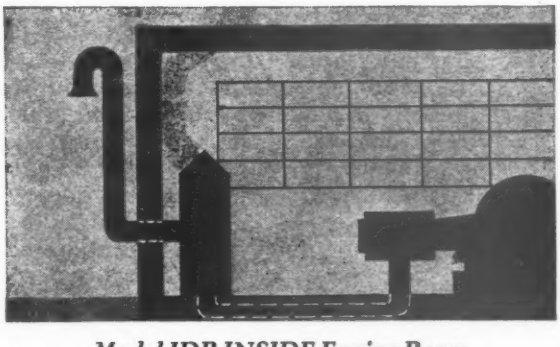
ALL THE CONVENIENCE OF GROUND LEVEL INSTALLATION

ALL THE EFFICIENCY OF HIGH LEVEL AIR INTAKE

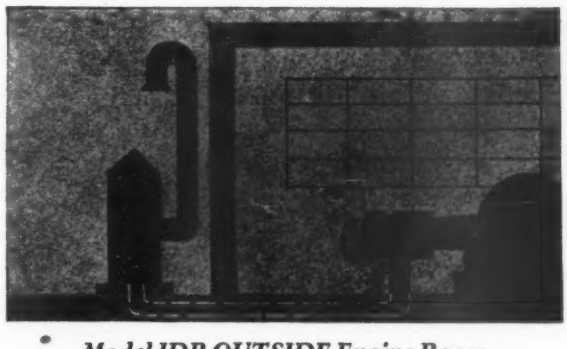
NOW you can equip compressors and internal combustion engines with a Staynew filter providing all the recognized advantages of the famous Protectomotor line . . . *plus* an exclusive combination of two new features.

The new filter, Staynew Model IDR, or IDRS (Silencer), is so constructed that *installation and servicing can be effected at ground level* (right in the engine room itself if preferred), and the *actual air intake located at the most suitable point.*

Models available with solid base for installation when compressor or engine intake is below floor level.



Model IDR INSIDE Engine Room



Model IDR OUTSIDE Engine Room

Engineering Data on request

STAYNEW PROTECTOMOTOR FILTERS

Representatives in Principal Cities

DOLLINGER CORPORATION

(Formerly Staynew Filter Corporation)

2 Centre Pk.
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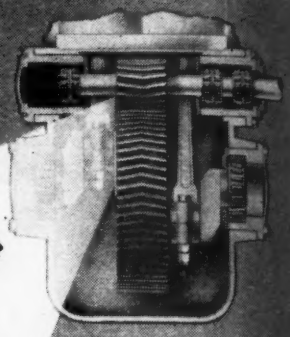
Quality UNDER THE MAGNIFYING GLASS!



HERRINGBONE GEARS . . . .

AMONG THE INGREDIENTS OF GASO SUPREMACY

- Large Valve Openings
- Individual Valve Chambers
- Deep Stuffing Boxes
- No Overlapping of Rods
- Babbitt Lined Shell Bearings
- Flood Lubrication
- Large Roller Bearings
- Alloy Steel Cranks Set at 90° Angle
- ✔ Alloy Steel Lapped Herringbone Gears

The gears of a Gaso Pump are Herringbone Gears, made of special-formula alloy steel, and center-mounted to equalize loads on bearings. They are designed to give years of trouble-free service. But they alone don't explain the dramatic leadership of Gaso Pumps. They alone do not explain why of all available pumps Gasos were selected for the all-important military pipelines. That distinction is the result of overall design — a combination of many features each contributing to long life, minimum attention and effective performance . . . Gaso Pump & Burner Mfg. Co., 902 East First Street, Tulsa, Oklahoma.

Export Office: 149 Broadway, New York. Shreveport: W. L. Somner Co., 419 Lake Street. Los Angeles: Production Equipment Co., 651-653 E. Gage Ave.

GASO PUMPS

for every oil industry need

Get 3-Point service with

THREDKOTE

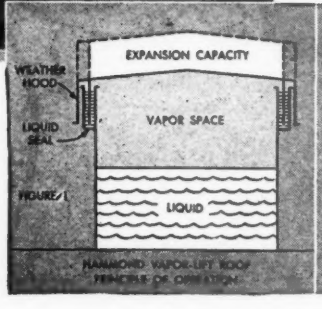
HUMBLE THREDKOTE IS REG. U.S. PAT. OFF.
By H. O. & R. CO.

There are eight **Thredkote** Compounds, each with special qualities developed to give the best service on specific types of threaded connections. But *all* **Thredkote** compounds render this important 3-point Service: they lubricate, they seal and they prevent rust. Whenever you need a leak-proof seal on any type of threaded connection, the name to remember is—**THREDKOTE.** Ask for **Thredkote** at your favorite supply house.

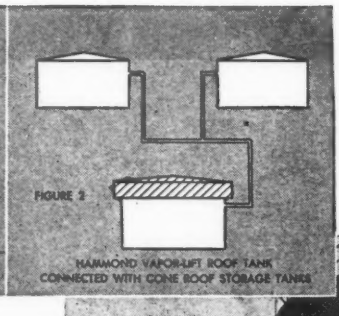
HUMBLE OIL & REFINING COMPANY

HAMMOND Vapor-

HAMMOND VAPOR-LIFT ROOF TANKS provide a variable vapor space, of ample capacity, to permit the expansion or contraction of vapors thus eliminating breathing.



HAMMOND VAPOR-LIFT ROOF PRINCIPLE OF OPERATION



HAMMOND VAPOR-LIFT ROOF TANK CONNECTED WITH CONE ROOF STORAGE TANKS

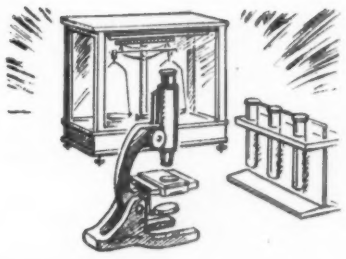
The variable vapor space in a Vapor-Lift equipped tank is positively sealed so that vapors will not escape, breathing losses will be eliminated, filling losses reduced and the quality of the stored product maintained.

Under normal conditions the Vapor-Lift Roof will rest on the roof supports as in the conventional cone roof tank. As the volume of vapor in the tank tends to increase the roof will rise to make room for the increased vapor . . . lowering itself when the volume of vapor tends to decrease. The Vapor-Lift Roof is designed to provide sufficient vapor space to eliminate all breathing and evaporation losses. Figure 1.

A single Vapor-Lift Roof Tank *(Available in sizes up to 100,000 bbl.)* can be provided with excess vapor capacity to accommodate the breathing of additional cone roof tanks. Figure 2.

Bulletin VLR-1 containing complete details, will be sent upon written request.

CARE*



. . . . the watchword in qualifying material for Marsh Gauges . . . .

THERE is a too prevalent theory that good design and careful workmanship can make up for the faults of poor material. We don't accept that idea here at the Marsh plant. We believe that to come out right, we must start right. So the lasting accuracy you have come to associate with Marsh Pressure Gauges begins with meticulous selection of the materials that go into them.

One of the best examples of this is the verifying of the tubing used for bourdon tubes. This tubing is the heart of the instrument. If it lacked the required resiliency it would take a "permanent set"—fail to return to its original arc when pressure ceased. That's why we micrometer every length of it as illustrated here . . . test its hardness on the device shown . . . bend and form it by exclusive Marsh methods.

You will find similar examples of carefully selected material in every detail of Marsh Gauges. And while it is true that Marsh design and precision workmanship are the final factors in making Marsh Gauges "The Standard of Accuracy", the story of making a superlative gauge would not be complete without this painstaking verification of materials.

Naturally material that will pass such rigid inspection costs more. But its cost is well justified in the finer pressure gauges, and dial thermometers that we are enabled to produce.

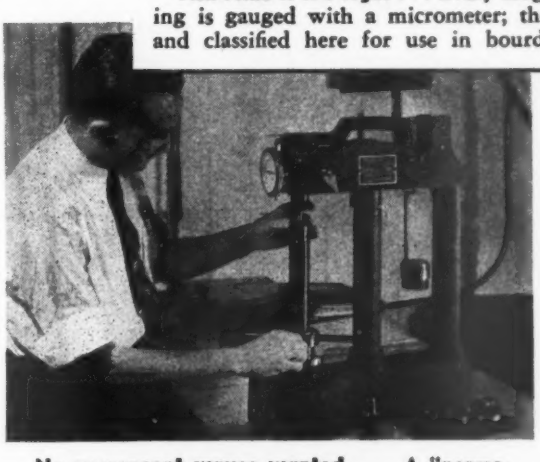
JAS. P. MARSH CORPORATION
2097 Southport Ave., Chicago, Ill.

Good news for the petroleum industry is the Marsh Branch plant at Houston. It means prompt shipment from a complete stock . . . complete engineering service . . facilities for repairing all makes of gauges.

MARSH HEATING SPECIALTIES
DIAL THERMOMETERS **GAUGES**

** One of a series of advertisements covering the factors that make Marsh instruments "THE STANDARD OF ACCURACY"*

Ask Mike if it's right . . . Every length of tubing is gauged with a micrometer; then tagged and classified here for use in bourdon tubes.



No permanent waves wanted . . . A "permament set" is n. g. in a bourdon tube. Here each lot of tubing is tested for hardness to make sure it doesn't have this fault.

Form counts . . . Tubes for heavier gauges are heat treated and formed here.

WHEN YOU'RE DRILLING 'EM DEEP...

...a good name to remember

All flanges look pretty much alike . . . but there *is* a difference. The experienced buyer of flanges who keeps a record of performance is well aware of this . . . and he knows it pays to specify Phoenix.

Phoenix Flanges are drop-forged from a mild steel especially suited to welding and machining, and they're available — for immediate shipment—in a wide range of styles and sizes. They can also be supplied, on special order, in stainless steel, Everdur brass, and other alloys. And, of course, they comply with ASA requirements and ASME and ASTM specifications.

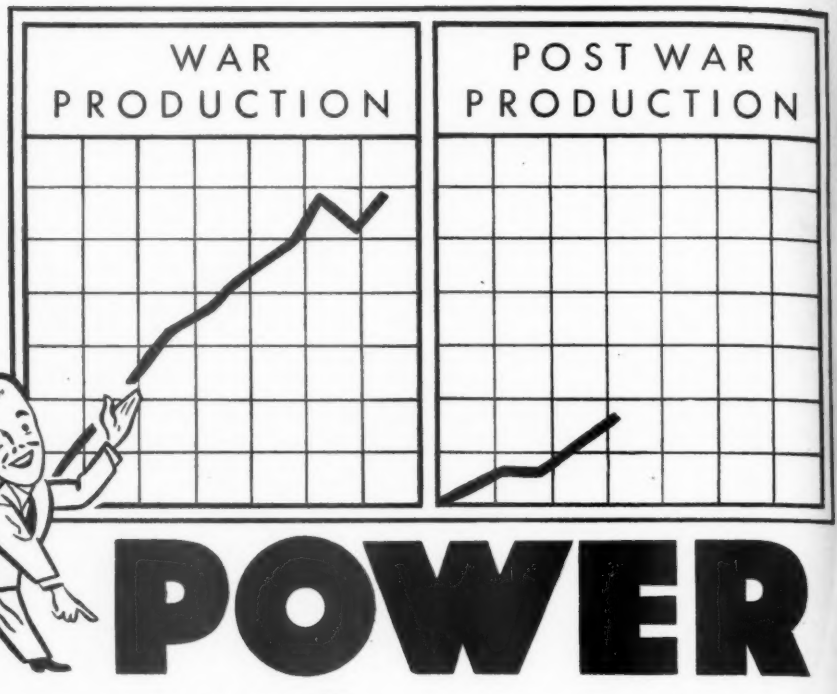
Ask your supplier for Phoenix Drop-Forged Flanges or write direct for our catalog.

FLANGE DIVISION OF

PHOENIX MANUFACTURING COMPANY

CATASAUQUA, PA. JOLIET, ILL.

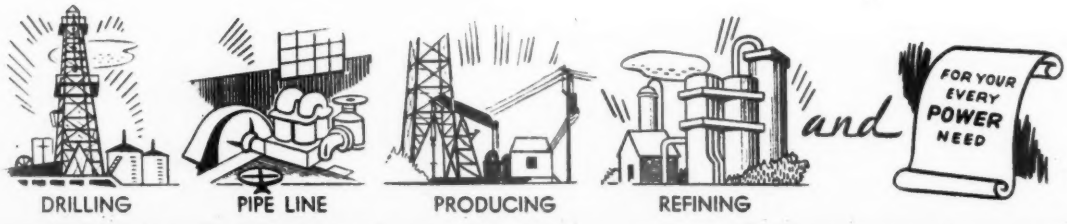
Tackle THIS JOB *with* POWER



THAT'S CAPABLE OF Doing THE JOB

YOU can't get around it—Utility Electric Power is the most versatile of all types of power. It has proved capable of providing the very best in power performance, regardless of the size of the job, or when or where the job had to be done. In looking forward into the near future, into long range plans, you should learn how you can benefit by Utility Electric Power's supreme performance on the basis of sound economy which will reduce your production costs, and help to increase your profits.

The power engineer of your electric power company is ready to show you how to tackle your every power job with power that's capable of doing an outstanding job.



POWER GEARED TO THE TEMPO OF EACH NEW DAY

Use Utility Electric Power!

PETROLEUM ELECTRIC POWER ASSOCIATION

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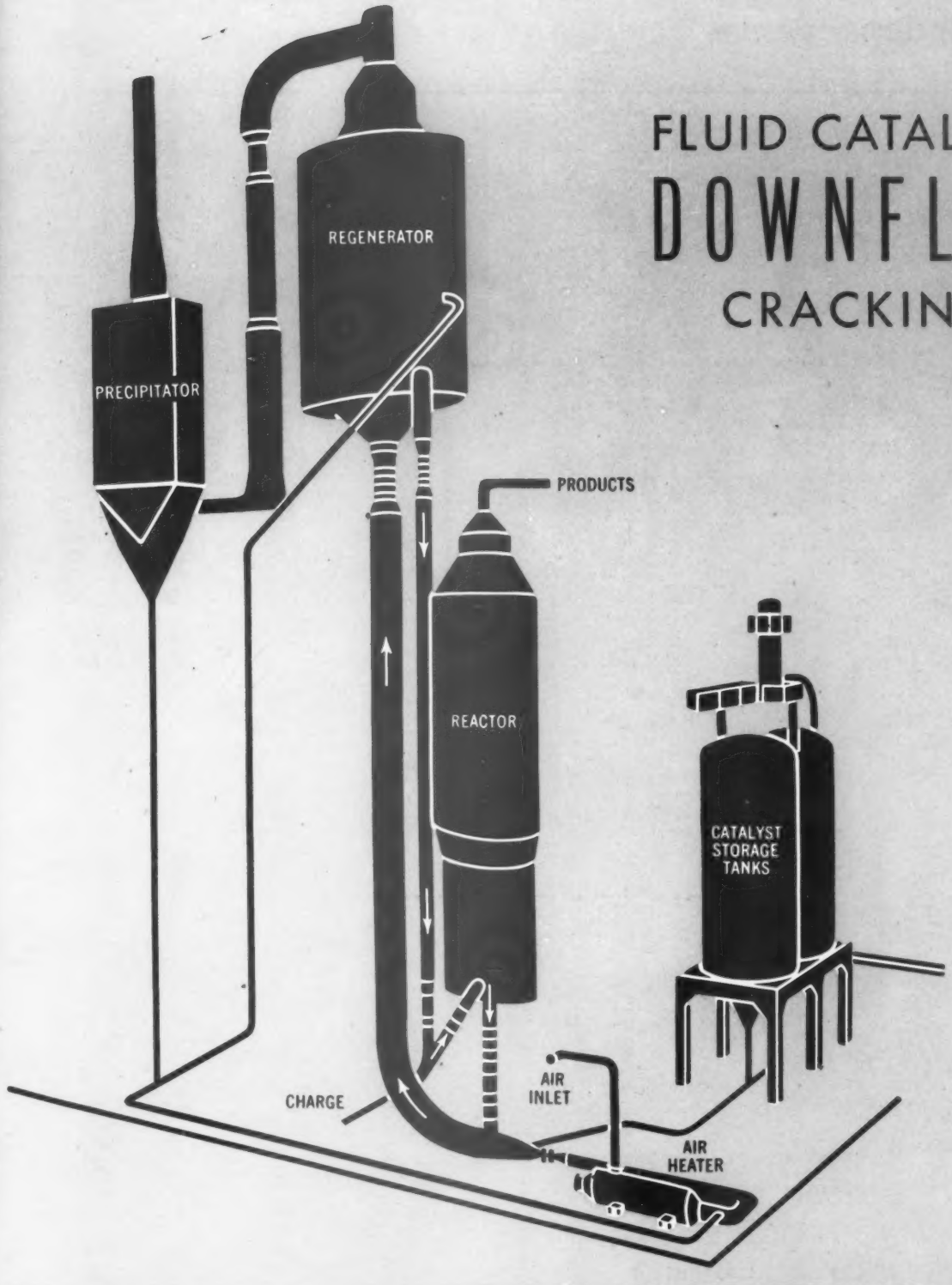
FLUID CATALYTIC DOWNFLOW CRACKING



Cost per gallon of Gasoline (of comparable Octane) is the only true measure of the overall efficiency of a cracking process.

Octanes (as high as 99.8 Research)—Charges (as heavy as 90% at 1065°F.)—"Onstream" (as long as 6 months) are operating accomplishments which classify FLUID CATALYTIC "DOWNFLOW" CRACKING as the most economic method for producing HIGH OCTANE MOTOR GASOLINE.

Reprints of the technical description and advantages of this improved catalyst flow, titled "IMPROVED FLUID PROCESS FOR CATALYTIC CRACKING" by E.V. Murphree et al (presented at the November 1944 meeting of the A.I.Ch.E.) are available on request. Address Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.

FOSTER WHEELER

"Octane Independence"

Octane competition is no problem to a refiner using FLUID CATALYTIC CRACKING. Performance records covering a wide variety of operating procedure represent substantial proof, that a "FLUID" unit can place a refiner in that desirable manufacturing position of being able to meet any competitive Octane situation.

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They don't come much more special

★ You won't find a welding fitting like this listed in anybody's catalog. In addition to having integrally formed side outlets, probably never before provided in a welding elbow, these are "special" all the way — special steel, special size and special wall thickness.

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That is why you find features in WeldELLS that are not combined in any other welding fittings . . . tangents . . . extra metal distributed where strains are greatest . . . extremely accurate dimensions . . . just to mention a few that call for special processes and complete knowledge of forging technique. Check the list of features opposite and you will agree that in everything conducive to sound engineering and utmost economy in pipe welding—

WeldELLS alone combine there features:

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- **Tangents** — keep weld away from zone of highest stress—simplify lining up.
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- **The most complete line of Welding Fittings and Forged Steel Flanges in the World**—insures complete service and undivided responsibility.

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The thing that makes a drilling rig great is *performance.* And, as for yourself, you can gauge your success in drilling and the amount of profits you realize, to an important extent, to the performance of your rig.

Because Wilson Rigs are engineered to give advanced drilling performance—with power, speed, easy operation, and economies you've never experienced before—they have established themselves as *standouts* in a truly modern power rig. Of course, you are the final judge, and we want you to sell yourself on a Wilson Rig. From then on, you'll always use Wilson Rigs.

WILSON RIGS and WINCHES may be purchased from the following: JONES & LAUGHLIN SUPPLY CO., MID-CONTINENT SUPPLY CO., INDUSTRIAL SUPPLY CO., BOVAIRD SUPPLY CO., and other recognized supply companies.

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McCullough

Gun Perforators for Greater Penetration

Proved by competitive field tests . . . proved by casing pulled from wells . . . proved by production records—the McCullough Armor-Piercing Bullet travels at *higher* velocity, punching cleanly through casing and cement, and drives deep into the formation, thus opening up a greater area of the producing zone. A major McCullough advantage!

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- Great Variety of Gun Perforators—more than 30 different types and sizes. One to fit your job!
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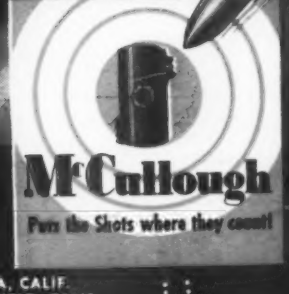
- Experienced Field Service Men.
- Up-to-the-Minute Equipment.

Ask Your Nearest McCullough Service Man



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